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GEOLOGICAL SURVEY OF GEORGIA.

FIRST REPORT OF PROGRESS
1890-91.

J. W. SPENCER, A. M.;
Ph. D. (Göttingen); F. G. S. (A. & L.);
STATE GEOLOGIST.

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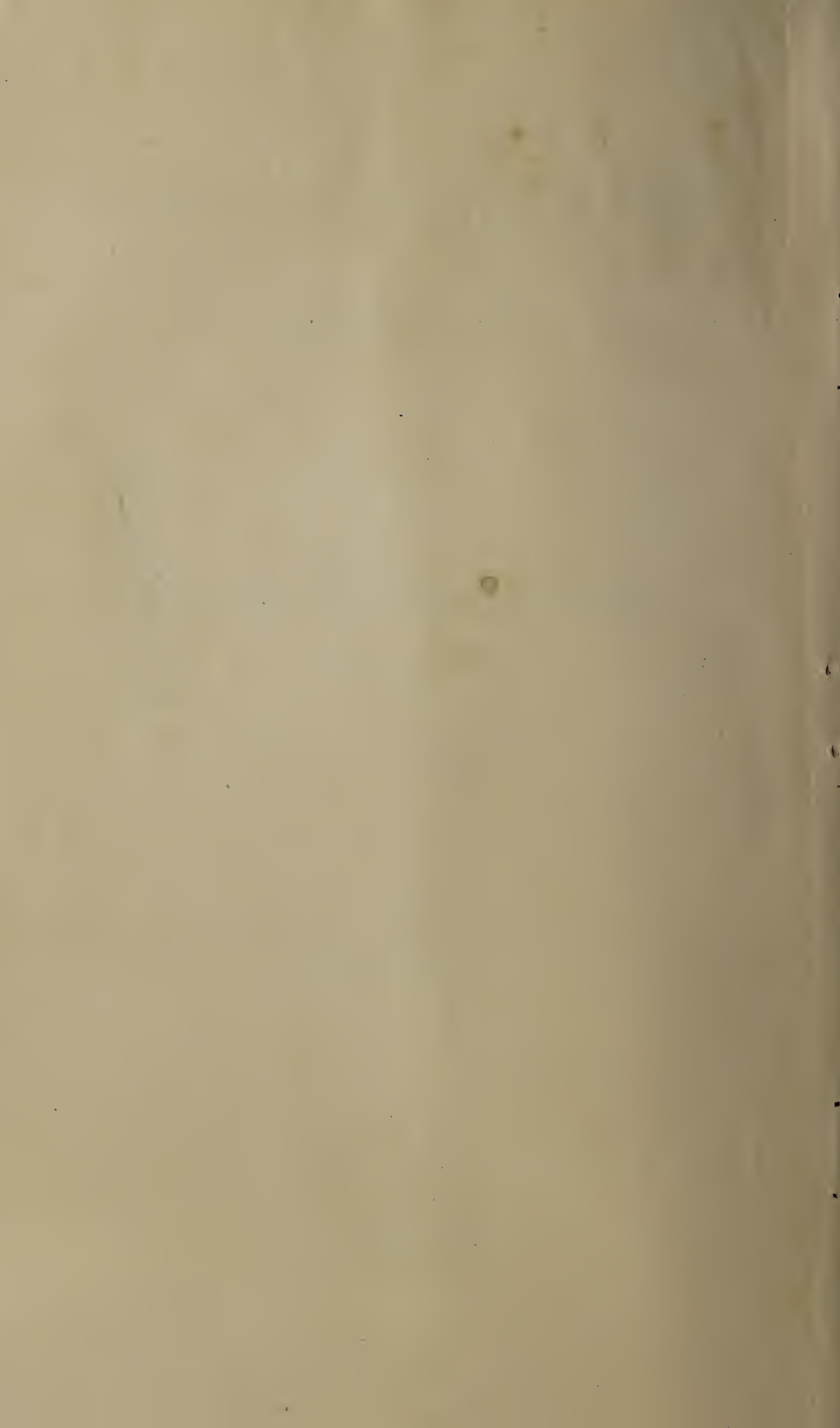
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Geology

ADMINISTRATIVE REPORT.

ATLANTA, July 1, 1891.

*To his Excellency, W. J. Northen, Governor, President of
the Geological Board of Georgia:*

SIR—Under the law reviving the Geological Survey of Georgia I was appointed State Geologist by your predecessor; and two assistants were appointed by the Board. Upon July 1, 1890, I assumed the duties of my office, with the assistance of Mr. C. C. Anderson, civil engineer, in charge of the hydrographic work of the survey, and Mr. E. T. Whatley, as Assistant Geologist. On July 2d, the Board met and adjourned until the 12th, in order to obtain bids for camp equipments, after which the outfits were procured as quickly as possible.

Under the law, two Assistant State Geologists, engineering and chemical work, as well as the outfits, were required. The appropriations were entirely inadequate. Nearly \$1,700 have been spent in partial equipment, and over \$1,300 in field and office expenses. Under the law, each officer was to have charge of a separate section of the State. But only one assistant could be provided for geological work, after the engagement of a necessary engineer, and only two field parties could be equipped. In order to overcome the stupendous difficulties of lack of funds, and give each section of the State a fair proportion of the labors of the survey, I have devoted nearly equal portions of my time in North and in South Georgia. The water powers, which are most largely situated in Middle Georgia, were entrusted to Mr. Anderson. Dur-

Msol., 7 Dec 64 rec'd., old Favorites Book-keeper, 1890/91, continue.

ing a portion of the year Mr. Whatley was attached to Mr. Anderson's camp, with instructions to conduct as far as possible a geological survey for ten miles on each side of the rivers, surveyed by Mr. Anderson; parts of Campbell, Coweta, Troup, Heard, Muscogee, Fayette, Clayton, Spalding and Upson counties. For a portion of the year, Mr. Whatley had one of the camp outfits, whilst Mr. Anderson or myself was engaged in office or field work, not requiring a wagon. During this time, he was working in counties south and west of Atlanta, surveying the whole of Harris, Talbot, Merriwether and Pike counties. By this method, the only one possible, I have given each section of Georgia such attention as the means would permit.

My own field work was as follows : A *reconnaissance* in Northwest Georgia preparatory to laying out the future work of the survey in that complicated section; a preliminary survey over Southwest Georgia, from the latitude of Columbus to the Floridian boundary, with a breadth of sixty miles; and a geological survey of Polk county, as the first of the county surveys in Northwest Georgia. In the *reconnaissance* in Northwest Georgia I traversed Fulton, Paulding, Polk, Floyd, Bartow, Chattooga, Walker, Dade, Murray, Gilmer, Lumpkin, White and Habersham counties. I had also previously twice crossed Bibb, Monroe, Upson, Meriwether and Troup, in geological explorations.

These explorations in Northwest and Middle Georgia gave me cross sections and outlines of the positions of the geological formations and the belts of ores. Owing to all of these districts having had their original strata disturbed by mountain movement of the earth's crust, I decided not to make a report for publication on insufficient data, and to wait for the surveys of the counties, having by this preliminary work been enabled to commence the

district investigations, deeming Polk county the most suitable as the basis of operations.

In making geological reports, the various States have adopted one or other of two methods: one in not publishing until a whole subject is completed, the other of publishing reports of progress followed by final reports. Whilst the law of Georgia requires a biennial report of progress, it does not require the premature publication of reports of scientific work. I accordingly submit such of the reports of progress as can be prepared at this early stage of the survey.

In the survey of geological formations, a group of structures is rarely confined to a district. Before the features or the relation of the resources of any county can be understood, the geological structure must be known, and hence considerable areas beyond that required must be examined. Consequently, the description applied to one county may be applicable to other counties, subject to local variations and local developments. Thus, the knowledge of the geological structure of Polk county greatly simplifies the investigations in Bartow, which closely resembles it. In the investigations of a region, the most difficult task is the first identification and commencement of work. I am gratified that it is possible to submit the first reports upon the districts surveyed, at this early date of the survey. Polk county is very rich in available iron ores, limestone (or tinted marbles), slate and other minerals, besides containing some of the best farming land in the State. For want of a chemist, the analyses of minerals and soils could not be made, and hence this portion of the report must be delayed.

Southwest Georgia does not present the disturbances and upheavals of Northwest Georgia, accordingly the survey of this larger area can progress more rapidly. Prac-

tically no scientific information, concerning this region was attainable, when the survey was commenced.

Whilst my camp equipment was being prepared, last July, I visited Thomas county and found that the phosphate deposits were of value, but there was no geological data to work upon, except such as I ascertained in the district. I was also consulted about artesian wells, but upon this subject no information could be given, as the character of the geological formations, and their extent were unknown. This great lack of knowledge caused me to give South Georgia my early attention, and in October the work was commenced, by a joint exploration along the Chattahoochee river, by the geological surveys of Alabama, the United States and Georgia, the officers being State Geologist Smith and Mr. Langdon, of Alabama, Mr. L. C. Johnson, of the United States Geological Survey, and the writer. Subsequently I spent several months in this work, descending the Flint river and making cross sections, which have enabled me to prepare a preliminary report accompanied by a general map. This work will serve as a basis of future operations, and covers more or less of Decatur, Thomas, Brooks, Mitchell, Miller, Early, Baker, Dougherty, Calhoun, Clay, Quitman, Randolph, Terrell, Lee, Sumter, Dooly, Webster, Stewart, Chattahoochee, Marion, Schley, Macon, Crawford, Taylor and Muscogee counties. This preliminary report was indispensable, as no small district could have been completely surveyed, for the general relations were not known; and the want of a chemist would have delayed the final report upon soils, phosphates and minerals, although it is the province of the geologist to trace out the different formations.

Besides the time occupied in by field operations, a great deal of labor is required in concentration and digestion of facts collected, so as to mould order out of disorder and

make an intelligible report. Also much labor is consumed in map making. This is shown in the report of Prof. Little, former State Geologist, who records the fact that for four months, in 1875, the whole corps was engaged in office work, and ordinarily one officer was constantly in charge of the office. But our office has been closed most of the time, except from November to early February, and since that time it has been open for only a few weeks, whilst I was preparing reports.

Great numbers of inquiries have been made with regard to the mineral and economic resources. Amongst these I call especial attention to "Bauxite," one of the two minerals from which aluminum is extracted. This mineral occurs in Floyd county, and is also said to occur elsewhere. It will likely open up a new industry in Georgia. Already, I have put myself in a position to answer many questions concerning artesian water. These are two classes of inquiries, which are recent, but most important. The healthful water supply, in South Georgia, is really a first question, even coequal with agriculture, and before minerals, such as phosphates, marls, etc. Not only the towns, but also many farms, can so obtain water, yet there are districts where search is useless. The survey is now in a position to give the first steps towards advice upon the distribution of water-bearing beds.

I herewith submit a preliminary report upon Southwest Georgia, along with a map of the general distributions of formations.

Mr. Anderson was intrusted with the water powers, which are most largely situated in Middle Georgia. He has made the first survey of the powers along the Chattahoochee and Flint rivers and subordinate creeks, and is now engaged upon the Ocmulgee river. The report cannot be published as yet. In the survey of water powers, at various points of discharge, the river must be examined at

different stages of the water, and water-stage meters must be read for a time, before valuable results can be obtained. An estimate, based upon one survey of the various shoals at the variable seasons, does not afford reliable information, and accordingly the results will not be offered at present; but the list of shoals will show that the work is in active progress. These powers will be reported as soon as sufficient data of fluctuations of the rivers shall have been obtained.

Mr. Whatley was intrusted with the geological surveys of certain counties southwest of Atlanta. His duties have kept him at field work without opportunities for preparation of his reports, except that of Pike county, which he has submitted to you. The progress of the surveys by all the officers has been reported to you at various times, but all the work is not ready for publication.

As chief officer, responsible for the accuracy and progress of the work, I have been greatly embarrassed for want of adequate and financial means to carry on the work in the most satisfactory manner. To obviate some of these difficulties, the Geological Board unanimously recommended certain changes in the law, which have also been unanimously recommended to the House by the General Agricultural Committee. The bill is still pending.

I have here to acknowledge to the advantage of Georgia, the survey of the Chattahoochee being made jointly by the interested States. I also acknowledge the assistance from the United States map of a portion of Northwest Georgia, by Mr. C. Willard Hayes, of the United States Geological Survey, which has greatly expedited my work. I have the honor to be,

Your obedient servant,
J. W. SPENCER, State Geologist.

A.

GENERAL OR PRELIMINARY

GEOLOGICAL REPORT

— ON —

SOUTHWEST GEORGIA.

— AND —

REPORT ON POLK COUNTY.

By J. W. SPENCER.

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PREFACE.

Under the law creating the office of State Geologist, the different sections of the State are equally provided for, as to the amount of work that shall be done. The law also provides for such preliminary work in the different sections as may be deemed necessary. The purpose of the survey, as defined by the law, is to make known the physical character of the country, whatever is of scientific or economic value, and the agricultural and climatic conditions. Under this broad requirement of the Geological survey, I have devoted several months at investigations in southwestern Georgia, in that portion of the State south of the line drawn approximately between Columbus and Fort Valley, and the Florida boundary. This section of the State represents an area of about 7,500 square miles. The district is a natural division, as it embraces the whole breadth, from north to south, of all the geological formations present in South Georgia, newer than the Archæan crystalline rocks, which latter form the middle belt of Georgia. No authentic scientific information of this part of the State, whatever, had been obtained and preserved; consequently, the region was almost a *terra incognita*. The wisdom of commencing the survey of the southern part of the State from the western boundary has proved doubly wise. In the first place, the work was commenced where left off by the Alabama survey. In the next place, some of the formations, which are developed along the Chattahoochee river, narrow down to unimportant proportions in passing eastward. The investigations along the Chattahoochee river were jointly conducted by the officers of the surveys of the Border States, and by a representative of the United States Geological Survey, namely: Professor E. A. Smith, State Geologist of Alabama; Mr. D. W. Langdon, formerly of the Alabama Survey; Mr. Lawrence C. Johnson, of the United States Geological Survey, and the writer, as State Geologist of Georgia.

This river was found to be an exceptionally favorable line for geological exploration, as the waters have cut down the banks on one side or the other, so as to expose the subjacent rocks for almost its entire length.

In making a geological survey, the first investigations must be to obtain a knowledge of what formations are present, their characteristics and their distribution. No detailed work was possible in Southwest Georgia until after such a preliminary survey had been

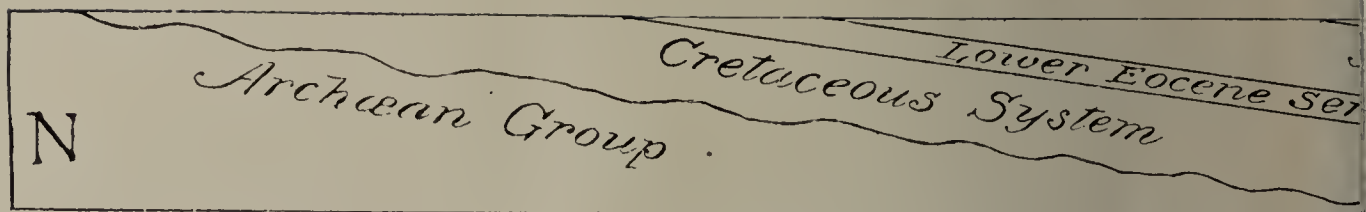
made, for the geologist could in no wise anticipate what he was next coming to. Such a general survey has now been completed, which will greatly facilitate not only the final surveys of that portion of our State, but be of assistance in carrying the work into Southeast Georgia. In this preliminary exploration, a less extensive investigation of the soils has been made than is required, partly on account of the survey not yet having been provided with a chemist; but some consideration of the question of soils is obtainable from their relationship to the sources whence they were derived,—information which can partly be obtained without the aid of chemical work.

My first official observations made in the State were upon the subject of phosphates of Thomas county. Going into the field, as was done, without a knowledge of the general geology of the southern part of the State, no generalizations could be carried beyond the immediate locality investigated, nor could the laws of the distribution be thereby determined; hence, the greater necessity for the completion of the preliminary work, which ought to be followed by a closely detailed examination. Another question of great importance is that of the supply of artesian water, for, up to the present time, I have found that the attempts to obtain such water-supply have been purely venture, without any intelligent pre-judgment. This could only be obtained after the country had been geologically surveyed.

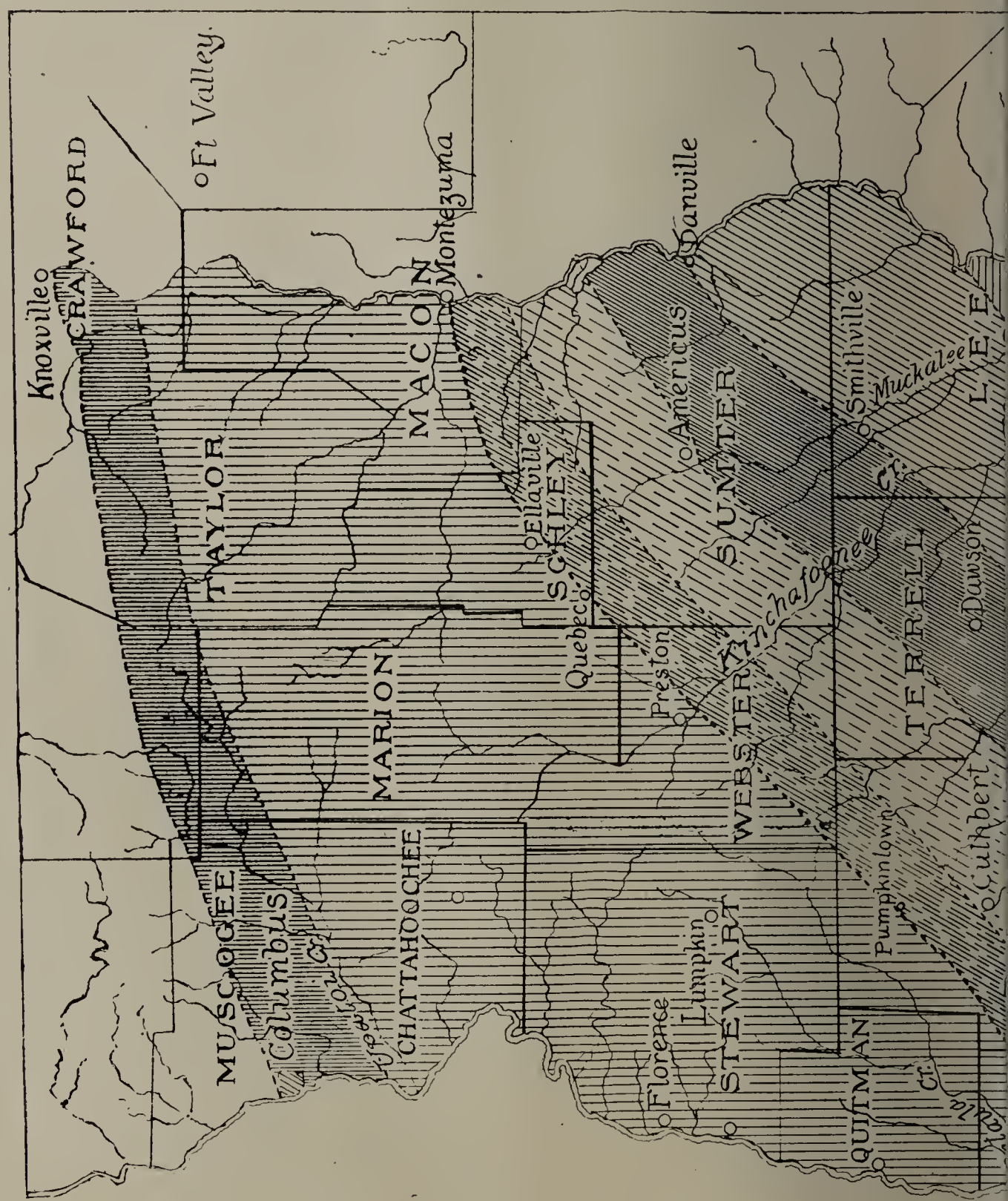
In the general exploration now finished, I have traced across the belt of South Georgia, sixty miles in width, the boundary between the great Cretaceous and Eocene systems, and have found a much greater development of the former than was formerly supposed; also, the leading subdivisions of the Eocene have been somewhat approximately determined, by which I am enabled to construct a general map of this portion of our State.

In the following report, the scientific considerations will be supplemented by those on the economic relations to the geological formations in that portion of the State.

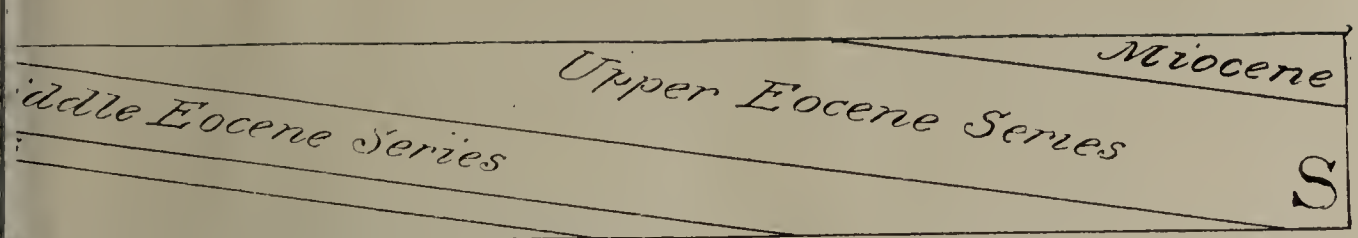
Appended is a copy of the original report by Mr. Langdon, along the Chattahoochee, which was re-examined by the Joint Surveys. This record has permitted of some abbreviations in my report. The appended geological section greatly expedited the joint survey of the river, as well as the preparation of this report.



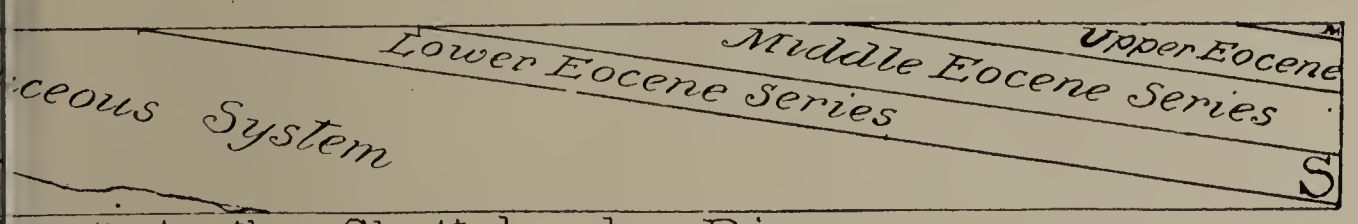
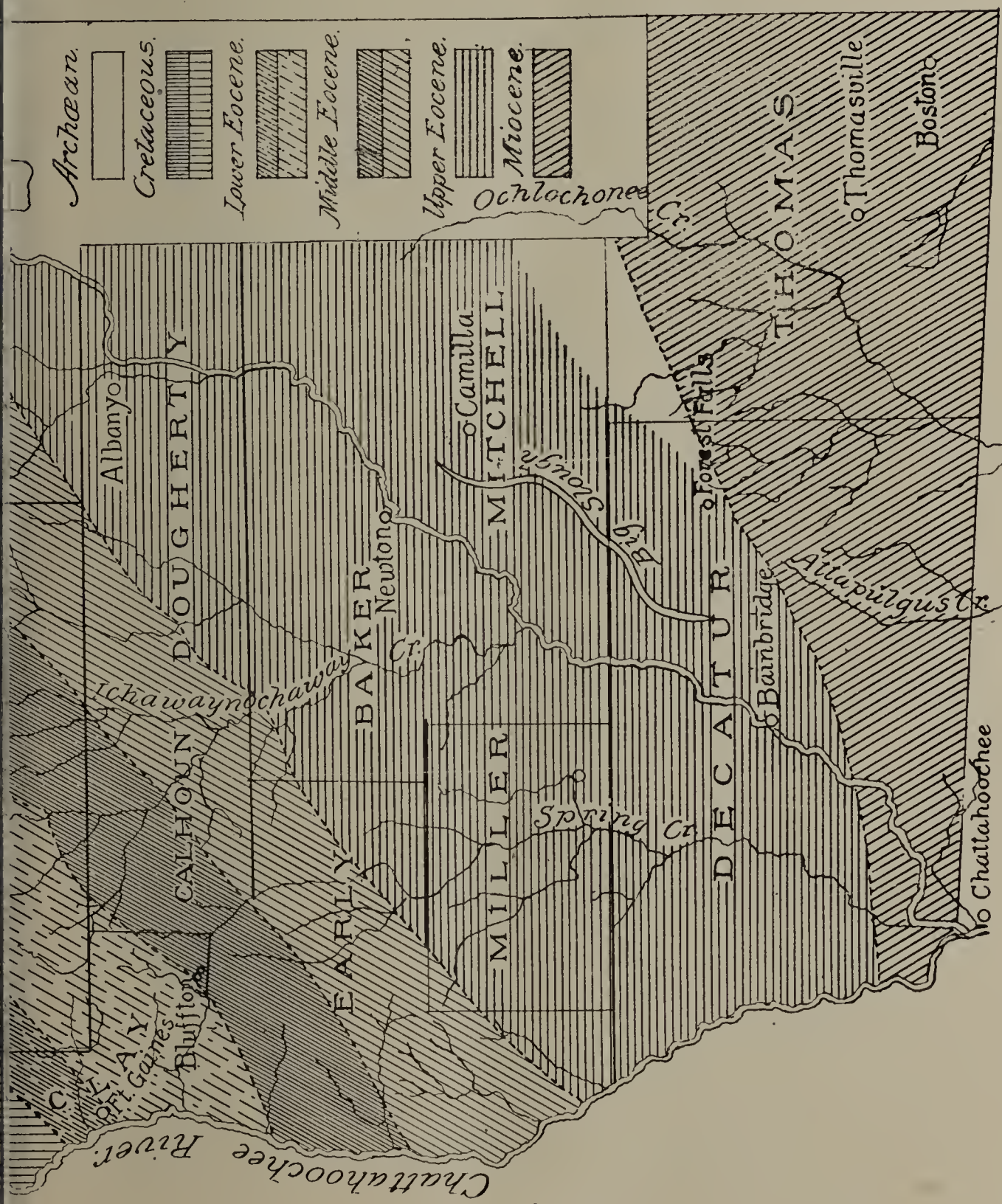
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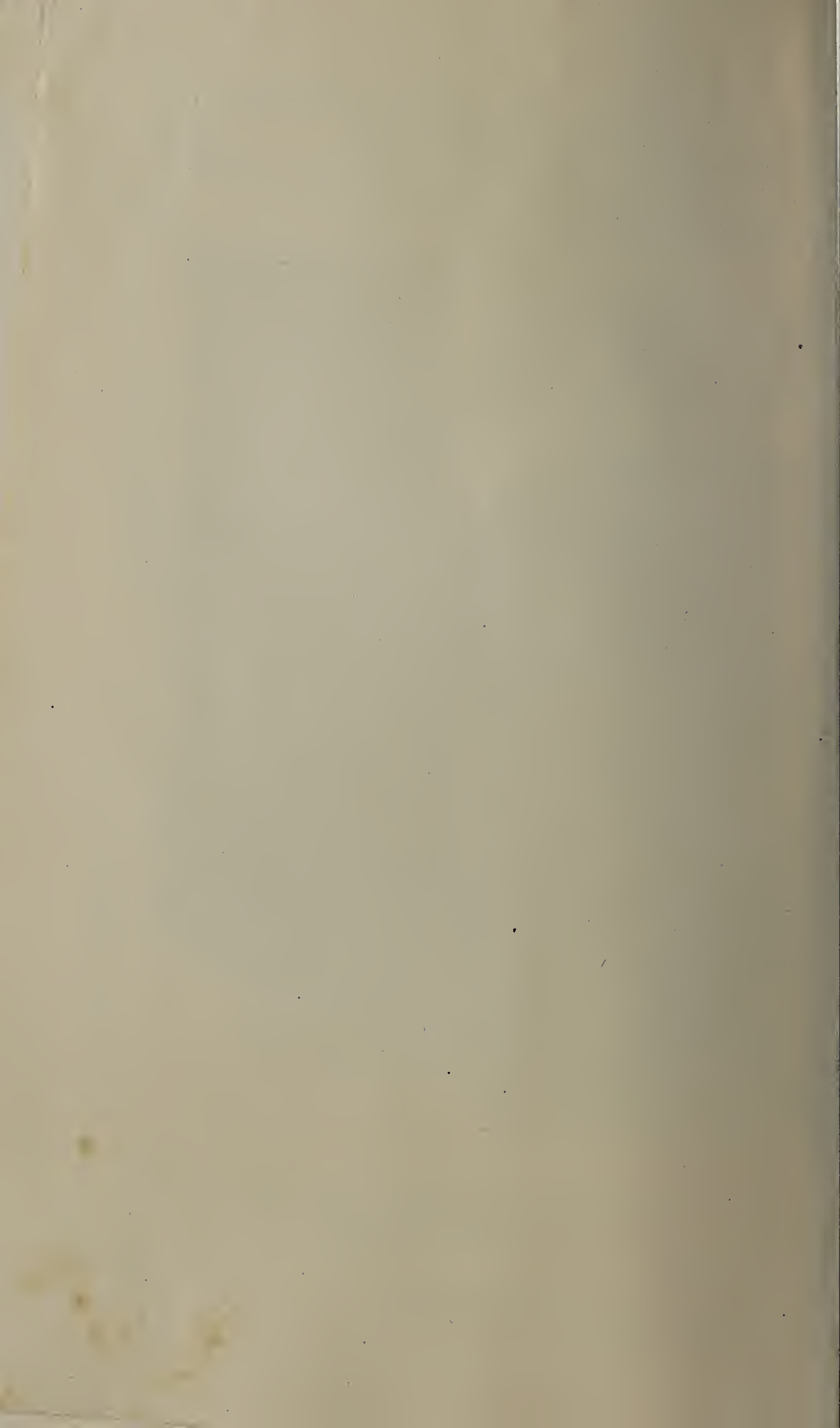


acent to the Flint River.



acent to the Chattahoochee River.

Tuscaloosa distinguished from remainder of Cretaceous; Midway from remainder of L. Eocene; Buhrstone from Claiborne (of M. Eocene); all by darker shades.



CHAPTER I.

GEOLOGICAL SYSTEMS IN SOUTHWEST GEORGIA.

Between the geological succession of strata which underlie the lands of the southern portion of the State, and the middle, there is a stupendous gap. The middle portion of the State is built out of crystalline rocks belonging to the oldest formations—the Archæan group. Resting unconformably upon them there are beds of clays, sands, marls, etc., often in an imperfectly consolidated condition. The line between such different materials is consequently easily defined and extends from Columbus to Knoxville and eastward. The section of the State under consideration is that portion lying between this southern margin of the Archæan belt just defined and the Floridian boundary, occupying about 7,500 square miles. Crossing the country, the different geological series succeed each other, in which there are inscribed the records of the building of Georgia, and the relations between the formations and the physical features; the soils; the material resources, and the habitability of the different localities; hence it is necessary to anticipate and tabulate the great geological groupings, which are represented in the southwestern portion of the State, in descending order:

Groups.	Systems.	Approximate thickness in feet.
Cenozoic. (Tertiary).	{ Pleistocene.. .. .	150 feet.
	{ Pliocene.....	Doubtful.
	{ Miocene.....	300 feet.
	{ Eocene	1500—1600 feet
Mesozoic. (Secondary).	{ Cretaceous.....	1645.
	{ Jurassic.....	Doubtful.
	{ Triassic.....	Absent.
Palæozoic. (Primary).	{ Permian.....	"
	{ Carboniferous.	"
	{ Devonian.....	"
	{ Silurian.....	"
	{ Cambro-Silurian or Ordovician.	"
	{ Cambrian.....	"
Archæan.	(As yet not differentiated into systems in Georgia).....At base.	

CHAPTER II.

THE GEOGRAPHICAL FEATURES.

The topographic features of Southwest Georgia bear a strong contrast to the mountainous portions of the State, but its uniformity disappears upon closer inspection; for whilst across it no mountains have been upheaved, yet the different rivers have moulded portions of the country into a succession of hills and deep valleys, obliterated and partly filled the valleys which they have made, or have left other districts almost unscarred. This sculpturing of the country by the rivers has not been continuous, but has been interrupted by many geological changes, during which land surfaces of one epoch have been buried beneath the materials of the succeeding, primarily derived from the wearing away of the Archæan formations during the great portion of geological time, when the Palæozoic and most of the Mesozoic systems were being formed elsewhere beneath the sea, above which Georgia rose as the southern extension of a long island.

The marginal portion of the metamorphic country consists of a succession of broad, rounded hills passing into rounded valleys without the abrupt features of newly made mountainous countries. One series of hills succeeds another, yet, deceiving the eye, they are found to vary but little in height. This ancient and softened topography forms the character of the country just north of the section upon which this report treats, seldom rising higher than 700 feet above the level of the sea, and in the valleys of the Chattahoochee and Flint rivers to about 250 feet.

The country south of the metamorphic line presents quite a different appearance. Commencing with a similar altitude, there is a succession of high plains, rising in places to about 700 feet above the tide, but deeply incised by the succession of rivers and streams, which have frequently carved down the abrupt valleys, as the streams have not yet reached the "base-level" of erosion. Thus the country is often more rugged than the older metamorphic zone to the north. Whilst the general altitude of this sculptured plain descends southward, yet the streams have carved out valleys often to as much as 200, and sometimes 250, feet beneath the adjacent plains. The excavations of deep valleys through the plains is more pronounced in the vicinity of the Chattahoochee and the Flint than farther away from

these great rivers. Still, this striking topography bears a close relationship to the distribution of the Cretaceous system, whose lower margin is not any more elevated, but has been longer exposed to the corroding action of meteoric agents than the more southern formations of the Eocene period. This contrast is most perceptible in the streams distant from the great rivers, for, where distant from the great rivers, the streams in the Eocene country are flowing in shallow depressions, but those of the Cretaceous are flowing in deep valleys. The Cretaceous country, approximately north of the line from near Fort Gaines to Montezuma, may be briefly defined as consisting of extensive high plains traversed by deep, narrow valleys.

From the descending margin of the Cretaceous belt, the features of the country, underlaid by the Eocene formations, gradually become less pronounced, and although the maximum elevation may reach 500 feet, yet it commonly descends to lower levels. The northern marginal portion of the Eocene country is characteristically a belt along which small lime sinks are common. These often form ponds or lakes. Further southward, except adjacent to the great rivers, the Eocene plains are rarely sculptured by valleys deeper than fifty or sixty feet. The country underlaid by the lower portions of the Eocene system is watered by numerous streams. The southern limit of this belt may be approximately drawn across Lee, and the northern portion of Calhoun and Early counties. South of this line the country is underlaid by formations which belong to the middle and upper Eocene series, which have affected the topographic features. Over this belt much of the country is remarkably level and interrupted by few streams, as the rainfall is often carried off by subterranean passages, through underlying, cavernous limestones, hence the absence of numerous small valleys. This broad belt of country is further characterized by lime-sinks, ponds and occasional sloughs, and has an elevation from 170 to 250 feet above the sea. These sloughs are simply the depressions of the broad plains, whereon the water accumulates during rainy seasons, owing to the imperfect, superficial or otherwise subterranean drainage. The largest of these depressions is that of the great slough through Mitchell and Decatur counties, which is over thirty miles long. It is apparently a broad, flat plain, when not covered with water, from one to two miles wide, with occasional ponds. During extremely wet seasons this lowland becomes flooded and overflows into the Flint river, near Bainbridge. Under the subject of Drainage this region will be referred to again.

Small branches frequently flow into the sloughs and ponds and are then lost. The waters of some of these ponds are healthful, clear and deep. Many ponds are evanescent—their periodicity varying from wet seasons to even several years, when their subterranean outlets become closed to be again suddenly reopened. In several

cases seen, the lime-sinks are not filled with water, as the streams run out as fast as they enter. The most remarkable of these sinks, is in the northeastern portion of Decatur county, at Forest Falls. Here is a lime-sink 100 yards long, with a base of the bowl about 60 feet in diameter, having some small caverns opening into it. Into this pit a permanent stream descends, at first by rapids and then cascades 90 feet over a fall into the pit, whence it flows into a subterranean passage. The floor of the pit is only 70 feet above sea-level, although situated more than as many miles from the Gulf of Mexico. Many similar cascades were seen, sometimes falling into lakelets and sometimes into empty pits.

Passing from the Eocene to the Miocene regions, in Decatur and Thomas counties, the country again attains a higher elevation, reaching from 250 to 300 feet above the sea, and it is traversed by valleys from 50 to 80 feet deep, or more, as they approach the Chattahoochee river. Over this more elevated and rolling country there is an absence of lime-sinks, but another belt is again met with in Florida and the southern part of Thomas county.

The topographic features along the Chattahoochee and Flint rivers need some special notice.

In the growth of the State, these rivers have been developed from the north towards the south. These early valleys were much greater than at present, and were formed when the whole region was vastly higher than it is to-day, as shown in another paper by the writer.* The continent then stood at an elevation of 3,000 feet or more above the present altitude. During this high continental period the Chattahoochee valley, in Muscogee and adjacent counties, cut out its broad valley from one to two miles or more in width and to a depth of 300 feet or more; whilst the Flint valley, in Crawford county, with a breadth somewhat less, was reduced to 150 feet below the general plain. By the subsequent changes of the land and sea the great valleys were, to a limited extent, refilled with sediments, so that we now find between the elevated plains and ridges bounding the rivers, high-level terraces belonging to the valleys. The highest and most perfect of these broad terrace plains is about 100 feet above the river at Columbus, or 260 feet above the sea. Whilst this plain has been to a considerable extent eroded, still it forms a conspicuous feature, often a mile or more in width and maintaining a nearly uniform height, extending down the river to beyond the Georgia boundary. In the southwestern corner of the State this terraced plain has an elevation nearly equal to that of Columbus, rising to 255 feet above tide, or about 175 feet above the river.

Along the Flint river, in Macon county, there are extensive plains

*High "Continental Elevations preceding the Pleistocene Period," by J. W. Spencer. Bull. Geol. Soc. Am., 1882.

at 200 feet above the river, but these are not confined to the river valley. Lower terraced plains are met with farther down the river, and are well represented by the plain whose elevation at Bainbridge is 118 feet above the sea, or about 60 feet above the river.

Whilst, adjacent to both rivers, fragments of lower terraces are seen, especially along their lower reaches, there is a marked difference in the topography of the two rivers. The erosion and scouring out of the Chattahoochee channel has been vastly greater than that of the Flint, and as a consequence, the waters have carved their way through all of the sediments filling the ancient valley, so that along the water's edge, and in the bluffs which generally bound the river, exposures of the more ancient sediments are nearly everywhere seen; until the river enters Decatur county. There the bluffs recede from the river and the low bottoms are liable to be flooded. Above this county there is a comparatively small development of low bottoms, which are liable to overflows. The higher terrace-plains are rarely reached except by extreme floods, which have been known to rise at one point to nearly sixty feet. The features of the Flint river show a strong contrast; there, the erosion has not cut down the channel below the broad, low flood plains to any great extent. The stream generally flows through broad bottoms nearly a mile wide, and only rarely washes against and exposes the bluffs which bound the ancient valley. Hence, for geological investigation, the exposures along this river are inferior to those along the Chattahoochee; but there is also an economic bearing, for these lowlands are apt to be flooded by an ordinary high water, as in many places the channel is not over 15 feet deep. In some places the swamps are broad and very extensive especially in the upper portion of the valley. From a point, a few miles above Albany, the features somewhat change, and the river cuts a deeper channel in the upper Eocene rocks, leaving flood plains less liable to be overflowed than farther north. In this lower portion of the river there is also a large number of rock exposures, but at only one or two points are shoals formed, which materially affect navigation. Here, in the lower portion of the river, we find that the base-line of the erosion has been somewhat lowered, like the Chattahoochee, but the hard limestones, in the region of Lee county and below, have not yet permitted the general subsiding of the river level above that point, and hence the greater liability of overflows along the upper portion of the river.

At no point, above Albany, does the Flint river cut its channel wholly out of the Eocene rocks, for even where such are exposed, they appear only on one side or the other as a great proportion of the banks is excavated out of the superficial capping of sands and clays belonging to the Lafayette and Columbia formations, which will be noted later. Below Albany, however, there are several points where

the modern channel cuts directly across the Eocene limestones, although a greater portion of the banks of the lower reaches of the river are formed of the loose deposits, which occupy the ancient valley. The general characteristics of the Chattahoochee and Flint rivers do not assimilate until a region, a few miles above their junction, is approached, where the boundaries of both rivers are low lands, with bluffs receding to a distance. Whilst the Chattahoochee river cuts almost directly across hard calcareous rocks of the middle and upper Eocene formations, below Big Creek, in Early county; the Flint enters a country of the same character, near Danville in Sumter county, and flows diagonally across the same formations to near its mouth, thus passing over a vastly greater distance of hard materials which are more slowly excavated than those along the Chattahoochee. Along the Pataula, Upatoi and some other creeks entering the Chattahoochee, the streams are characterized in part by high bluffs favorable for geological exploration. Along the upper waters of the Ichawaynochaway, Kinchafoonee, Muckalee and Spring creeks, their valleys are unimportant, and often swampy without any great exposures of rocky banks; Such, however, rise into bluffs along their lower reaches, where limestones and marls form an important feature. In the southern part of the State, the Attapulgus and portions of the Ochlockonee and other streams observed, flow over low ground which is often swampy, with the bluffs situated not immediately upon the streams.

The topographic features of the southwestern part of the State are not difficult to understand. The elevations have been taken from such railway levels as were available, and from these points the supplemental determinations were constantly being made by the use of the aneroid barometer. From such data, the generalized description above given has been drawn; however, for further guidance, the railway levels available are here added. In some cases, the roads follow the water sheds, and there the altitudes represent the highest land. In other cases they follow the valleys; here, then the elevations represent low depressions, as for instance, in the case of Americus, where neighboring hills rise one hundred feet above the railway.

The highest lands, in southwest Georgia, extend, with some interruptions, from near Fort Valley, southwestward to Stewart county, the highest point being in the northeastern corner of the county at Brooklyn Station, on the Columbus Southern Railway, where the altitude reaches 691 feet.

Of the elevated ridge crossing the southern portion of Decatur and Thomas counties, Faceville is the highest point, with an altitude of 304 feet above the sea. Thomasville is situated a few feet above the railway elevation given (258 feet), and Whigham and other points to the west are somewhat higher.

The relationship between the topographic and geological features, is such that it has been necessary to give this brief outline before consideration of the geological structure of the country; also there is a close relationship between the topographic and agricultural features and habitability, which subjects will be considered in their proper places.

ELEVATION TO ACCOMPANY PRELIMINARY GEOLOGICAL REPORT ON
SOUTHWEST GEORGIA.

Station.	Elevation above Sea.	Authority.
Waycross.....	145 feet.....	S. F. & W. Ry.
Glenmore.....	159 ".....	"
Argyle	169 ".....	"
Homerville.....	124 ".....	"
Dupont.....	188 ".....	"
Stockton.....	196 ".....	"
Naylor	200 ".....	"
Valdosta.....	223 ".....	"
Ousley	156 ".....	"
Quitman	181 ".....	"
Dixie.....	139 ".....	"
Boston	202 ".....	"
Thomasville	258 ".....	"
Cairo.....	246 ".....	"
Whigham.....	273 ".....	"
Climax (Bainbridge Junction)	285 ".....	"
Bainbridge.....	118 ".....	"
Fowltown.....	297 ".....	"
Faceville	304 ".....	"
Recovery.....	197 ".....	"
Chattahoochee Junction.....	78 ".....	"
Camilla.....	170 ".....	Butt's Map.
De Witt	175 ".....	"
Humboldt.....	180 ".....	"
Albany	189 ".....	Central Ry.
Albany	172 ".....	Bruns & W. Ry.
" Valley of Flint.....	154 ".....	"
" Surface of water	127 ".....	"
East Albany.....	186 ".....	"
Macon.....	334 ".....	M. & B. Ry.
Seago's	362 ".....	S. W. Ry.
Byron.....	515 ".....	"
Fort Valley.....	522 ".....	"
Marshallville	492 ".....	"

Winchester.....	465 (?) 377.....	S. W. Ry.
Montezuma.....	300 feet	"
Flint River Bridge.....	305 "	"
Oglethorpe.....	300 "	"
Andersonville.....	396 (?)	"
Americus.....	348 feet	"
Smithville (83 miles).....	319 "	"
Kinchafoonee Bridge.....	265 "	"
Dawson.....	326 "	"
Nochway Bridge.....	283 "	"
Pachitla	340 "	"
Cuthbert	452 "	"
Cuthbert Junction.....	469 "	"
Morris.....	235 "	"
Fort Gaines.....	152 "	"
Fort Gaines, River Surface.....	100 " (about).	"
Georgetown.....	189 "	"
Eufaula, Ala.....	211 "	"
Ellaville.....	591 "	"
Knoxville	640 "	J. E. Thomas.
Columbus.....	260 "	Col. So. Ry.
Bull Creek.....	240 "	"
Upatoi Creek.....	225 "	"
Ochillee	289 "	"
Cusseta.....	532 "	"
Manta.....	515 "	"
Top of cut at Manta.....	565 "	"
Green Hill.....	601 "	"
Brooklyn.....	691 "	"
Richland.....	600 "	"
Weston.....	528 "	"
Parrotts	482 "	"
Dawson.....	376 "	"
Sasser.....	336 "	"
Oakland.....	275 "	"
Palmyra	260 "	"
Albany.....	208 "	"
Upatoi.....	432 "	Cent. Ry.
Geneva.....	600 "	"
Bostwick.....	669 "	"
Butler.....	650 "	"
Reynolds	433 "	"
Flint River.....	337 "	"
Everett's.....	362 "	"
Fort Valley.....	522 "	"

The above outline of the topography of the section investigated was necessary for easy understanding of the geological features, for although a consequence of the geological structure and forces, yet only from the study of the features can we determine whether or not the region is favorable to the preservation and investigation of the geological relations. From what has been already stated, we learn that the exposures along the Chattahoochee are exceptionally favorable for geological study, whilst those along the Flint are somewhat less so; even the scanty information from artesian and other wells, has enabled me to mould into order, the information obtained from the river sections and superficial cuttings along the railways.

Most of southern Georgia is covered by a superficial sheet of earthy matter, which conceals the underlying formations, and constitutes the soils. This mantle varies in character, and will form a distinct subject of consideration.

By the study of the accurate topography and dip of well characterized formations, the geologist can predicate their distribution and extent over considerable areas, and have some knowledge of the interior of the earth's crust, even when the same is not directly observable. But formations often change in composition and character. Sometimes they thicken or again thin out and disappear, so that in widely separated areas, the records will not be identical; but in Southwest Georgia the great formations maintain their general characteristics over considerable areas, although in some cases they become narrowed in passing eastward. As the dip of the rocks is very gentle, the same series or formations are apt to underlie broad belts of country.

CHAPTER III.

THE CRETACEOUS SYSTEM IN SOUTHWEST GEORGIA.

The positions of this assemblage of materials in the geological grouping have already been noted in the table on page 17. In other regions the Cretaceous strata are more extensively developed than in the Southern States. In the Eastern and Southern States, there are two large Cretaceous basins which are separated by portions of Georgia. The Atlantic Cretaceous basin extends from New Jersey southward. The Gulf basin crosses the Southern States and enters Georgia with a breadth of about fifty-seven miles along the Chattahoochee river; it, however, diminishes to a width of about twenty-four miles along the Flint river, eastward of which it is of small extent. In their study, these strata must be considered in their relation with the deposits of Alabama and westward.

The subdivisions of the Cretaceous system in the Gulf States, adopted by Dr. E. W. Hilgard, of Mississippi, in 1871, and followed by Dr. E. A. Smith, of Alabama, is represented in descending order, in the following table:

<i>Series.</i>	<i>Estimated thickness in feet.</i>
Ripley.....	250-275
Rotten Limestone.....	1,000
Eutaw (Coffee).....	300

At the base of these series, Dr. Smith added (with some question):

Tuscaloosa.....	1,000
-----------------	-------

This classification will be adopted in the present report.

Crossing the Gulf States, the formation undergoes a most notable change in the disappearance of one thousand feet of Rotten Limestone on approaching the Georgia boundary. On the other hand, the Ripley series undergoes a great thickening, from less than three hundred feet to nearly eleven hundred. Again, the Tuscaloosa series undergoes a shrinkage. This change is observable in comparing the above table with the succeeding section along the Chattahoochee river, first determined by Mr. D. W. Langdon.

SECTION ALONG THE CHATTAHOOCHEE RIVER.

Ripley Series.....	1,080 feet
Rotten Limestone.....	Wanting
Eutaw Series.....	385 feet
Tuscaloosa Series.....	180 feet

These Cretaceous deposits extend along the Chattahoochee from Columbus to a point about eight miles by river, north of Fort Gaines, and near the mouth of Sandy creek. In the region of the Flint river, the beds extend from Knoxville, Crawford county, to a point along the river about three miles above Montezuma, a distance of about twenty-four miles, although to the east of this meridian, the Cretaceous formations occupy a much narrower belt. The southern boundary of the system may be defined by a line drawn approximately between these points, passing near Ellaville, Quebec, Preston and Pumpkin Town. In drawing such a comparatively straight line across a map to represent the boundary between two formations, the topographic features, of necessity, modify its directness. Thus, where the lines cross deep valleys, the lower formation are found near the approximate line given, whilst unusual elevations of the land, cause the upper formation to extend in the opposite direction. Whilst the dip of the rock varies, sometimes appearing almost horizontally, and again increasing to one hundred feet per mile, yet the general average is reduced by return dips, whereby the same beds appear exposed for considerable distances along the river. The general average dip of Cretaceous formation, I have placed at twenty-five or thirty feet per mile towards the south southeast.

THE TUSCALOOSA (POTOMAC) SERIES.

Resting upon the deeply sculptured surface of the upheaved metamorphic rocks in central Georgia, there is a series of unconsolidated white, yellowish, gray, green or purple micaceous sands, gravel, and purple and mottled clays. The sands are often coarse, and held together with clayey matter. Sometimes they are strongly cross-bedded. These sands frequently resemble decayed gneiss so closely as to render mistakes liable when they do not contain rounded pebbles. Where gravel beds are developed, the pebbles are well rounded and water-worn, and commonly are composed of quartz, derived from veins in the metamorphic rocks of upper Georgia. In some localities the clay is white and kaolin-like, but it is often stained lemon color, along the lines of joints, by iron compounds, thus producing a mottled appearance. In many exposures this kaolin-like clay resembles pockets, or beds of decomposed feldspar, of the adjacent metamor

phic rocks. In valleys, both near Columbus and Knoxville, and elsewhere, the resemblance between these different clays is so strong that the observer must reassure himself of their true origin.

Such is the character of a series of deposits forming a belt, about eight miles wide, extending from Columbus to Broken Arrow Bend on the Chattahoochee river, where they are overlaid by fossiliferous beds of the Eutaw series. Such deposits are seen in exposures up to nearly one hundred feet above the river, near Columbus, and thence, down the river bed. The mottled clays are particularly well shown in the railway cut, opposite Columbus on the Alabama side of the river. Two or three miles above the mouth of the Upatoi creek, near the wagon-bridge, there is a fine exposure of these deposits in descending order, thus:

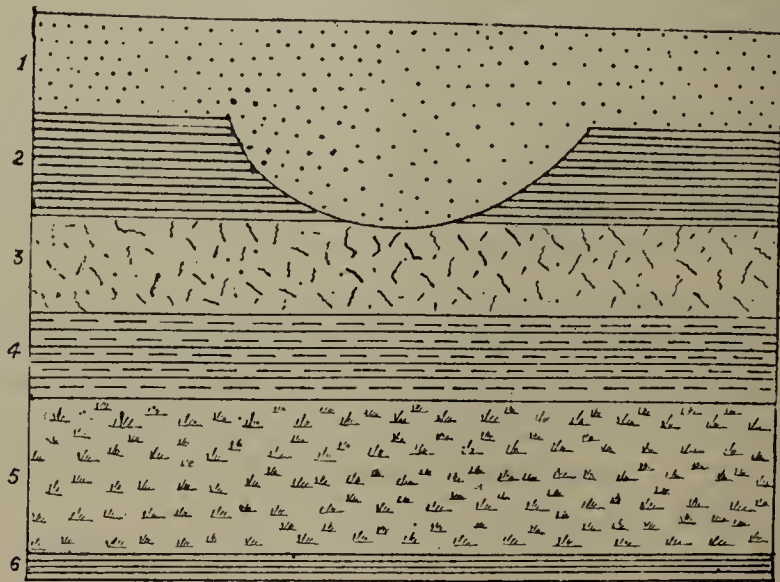


FIGURE 1.

1. A superficial covering of Lafayette deposits upon the sculptured surface of
2. Irregular laminated colored sands with streaks of white sandy clay..... 6 feet.
3. Coarse white and mottled sand with clayey binding..... 8 feet.
4. Gray sandy clay..... 6 feet.
5. Concealed..... 10 feet.
6. Dark gray, nearly black clay exposed..... 2 feet.

The surface of the formation under consideration is seen in many exposures where its surface has been carved out by streams, and again covered by recent geological deposits.

On the sides of the hills north and west of Knoxville, fragments of this series of deposits remain, but the mottled clays are not easily

distinguishable from the decomposed feldspar of the older deposits, but some of the layers are composed of coarse sand or grit containing a small portion of argillaceous matter. This geological formation probably extends southward to a line two miles south of Gaillard's Station, where purple mottled clays are unconformably overlaid by various beds of sands and clays referred to in the Eutaw series.

In the ravine, at Rich Hill (see figure beyond), about six miles southeast of Knoxville, the lower part of the section in descending order, consists of:

Light colored gray sand.	10 feet.
White micaceous sand.....	30 feet.
White kaolin-like clay with uneven surface exposed.....	10 to 15 feet.

These beds underlie Eocene limestone and the two lower beds probably belong to the formation under consideration. The average width of this formation, between the Flint and Chattahoochee rivers, may be given at about eight miles. It is also seen at Macon, but that locality is outside of the section under consideration.

These deposits have an estimated thickness of 175 to 200 feet. Farther west than Alabama, Professor Smith estimates the formation at 1,000 feet. It represents the first materials deposited after the enormous lapse of geological time, during which Middle Georgia formed an island above the sea, lasting throughout the greater portions of the Paleozoic and Mesozoic eras; but with the subsiding of the land in the later Mesozoic times, the materials, washed off the high-lands, were deposited in the neighboring sea along the receding shore line now represented by this belt of sandy and clayey deposits crossing Western Georgia in a belt of eight miles in width, although, in Alabama, their breadth reaches twenty-three miles, and further east in Georgia diminishes to small proportions, or perhaps may disappear.

These deposits in Georgia are the eastern extension of a large series, named the Tuscaloosa by the Geological survey of Alabama. They are probably identical with the Potomac series of the middle Atlantic States, of Mr. W. J. McGee. That they are older than the lower Cretaceous beds of the Eutaw series, is apparent, for these latter succeed them in Alabama and Georgia; but there is some uncertainty whether the Tuscaloosa series should be regarded as belonging to the lower portion of the Cretaceous or the upper portion of the Jurassic system, owing to the scarcity of fossils in their clays. The plant remains, found in Alabama, favor their correlation with the Cretaceous system, which is provisionally done in this preliminary report without stating the evidences.

The surface of the country, underlaid by these sands and clays,

which are often derived from them, is usually covered by heavy sand, except where the last are overlaid by Pleistocene clays, as along the plains of Columbus.

These sandy beds are water-bearing, and from beneath the layers of clay, springs are apt to flow; thus the ravine, which cuts into Rich Hill to a depth of 135 to 150 feet, has risen largely from the undermining of the beds by such springs.

The white clays require chemical and further investigation, as some of them may prove of value in pottery manufacture, as similar deposits in New Jersey have done. The clay at the base of Rich Hill series appears to be of fine quality, and in part covered by only eight or ten feet of sandy deposits.

THE EUTAW SERIES.

Overlying the Tuscaloosa series, the fossiliferous deposits of the Eutaw are found. The greater proportion of this formation consists of clayey sands often cross-bedded with less important beds of pebbles. Alternating with these silicious deposits, there are laminated beds of clay and sand. Some of these layers are indurated and characterized by large concretionary balls. This last feature is notably the case in the dark green pyritiferous calcareous clayey sands at Broken Arrow Bend on the Chattahoochee river, near the base of the Eutaw series. Another striking feature of these beds consists of the sudden transition in the material character of the deposits; thus beds of sand suddenly thin out and disappear, or pass into layers of pebbles; the laminated clays may change their character and be continuous with even cross-bedded sands. This change from laminated clay to sand is seen above the mouth of Uchee creek, and just below the mouth of Rooney's Mill Creek, along the Chattahoochee banks. The transition is well seen in the railway excavations about two miles south of Gaillard's Station (Mr. McCarthy's farm), where dark bituminous clays, with micaceous sandy partings, pass into gray sandy clays, and where sandy partings suddenly increase from a few inches to many feet in thickness; hence, we do not find two neighboring sections showing the same succession of materials. Thus, in three excavations, all within a quarter of a mile, the following sections are shown; the layers being given in descending order:—

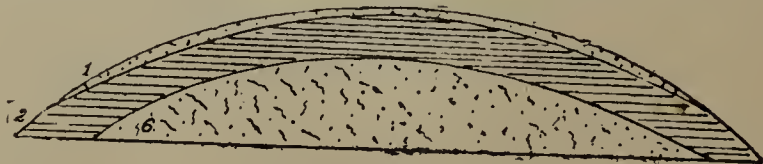


FIGURE 2.

Capping of red loam on an irregular surface of purple, white mottled clay.

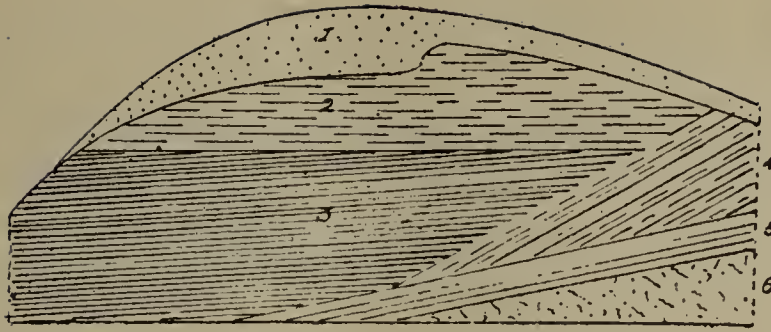


FIGURE 3.

1. Deep colored red loam upon an eroded surface... ..0 to 4 feet.
2. Horizontal laminated, grayish clays, with red sandy partings.....10 feet.
3. Dark colored green laminated clays, with micaceous, coarse white sandy partings, dipping 15 degrees at south end of section, 6 feet, at north end.....12 feet.
4. A wedge of red sand rising from beneath the southern end of the last bed and attaining a thickness in the next section of.....10 feet.
5. Seam of white clay, with red sandy partings, underlying No. 3 and No. 4, average3 feet.
6. Deep colored purple and white mottled clays, exposed at the end of the section.....4 feet.

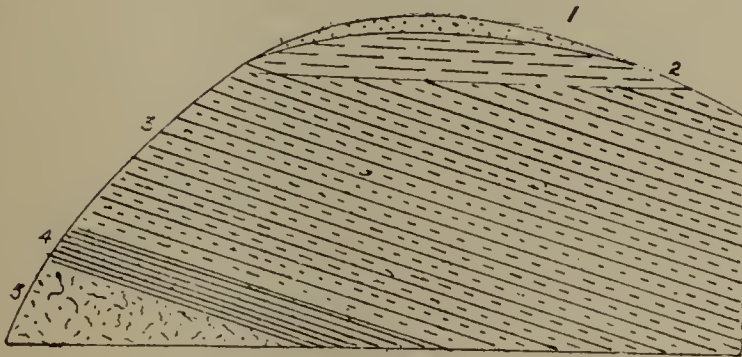


FIGURE 4.

1. Thin coating of red loam.....
2. Horizontal laminated grayish clay..... 4 feet.
3. Deep colored red sand, with some white and red laminated sand below, with white clayey partings throughout a portion of the mass. Dip 10 degrees to the south; maximum thickness20 feet.
- (This is an enlarged part of No. 4 of last section.)
4. Seam of white clay, with red sandy partings..... 3 feet.
5. Purple and white mottled clays, exposed at one end of section 3 feet.

In these and other neighboring sections, the only persistent layer appears to be the underlying purple and white mottled clay. This absence of persistent beds adds to the difficulty in exploring the formation. The constantly variable character evidently points to the formation of these mechanical deposits in rapidly changing currents, and in shallow water. Along the Chattahoochee river, examples of quartzose pebbles or conglomerates are seen at Hatcher's Lower Landing and just below Chimney Bluff.

Throughout the Eutaw sands and clays, along the Chattahoochee, calcareous rocks do not appear, except in so far as fossiliferous sands may have been rendered calcareous.

Some of the intercalated, arenaceous layers of this formation contain glauconitic or green sands.

The lower portion of the Eutaw series is well characterized by fossils, as at Broken Arrow Bend, where the indurated sands contain an abundance of *Amonia* and small *Exogyra*. Near the upper portion of the series at Chimney Bluff, species of *Exogyra* is also found, but generally speaking, elsewhere throughout the series, fossils have not been observed, except lignitized wood, twigs or leaves, which occur at several localities. Chimney Bluff, situated opposite Oswitchee Bend, and in the south-western part of Chattahoochee county, forms an exceptionally favorable exposure of the upper part of the Eutaw series. This bluff rises about 60 or 80 feet above the river, and owing to extensive land-slides, a characteristic feature of some of the Eutaw beds, the yellow sands and clays are well exposed. Near the base, lignitized logs were seen protruding, and some excellent layers of fossilized leaves. Just below the bluff there is an included bed of rounded, quartzose pebbles.

Although not yet observed along the Chattahoochee, it appears that in the upper members of the Eutaw series, in Alabama, there have been found indurated, calcareous sands, containing nodules of nearly pure phosphate of lime, phosphatized shell casts, and phosphatic matter in the sand itself. But these beds may possibly be related to the Rotten Limestone series.

The probable northern boundary of these strata is recognized about two miles south of Gaillard's Station, in the sections already noted. Another section about four miles southwest of the last named locality is seen at the western end of the approaches to the Southwestern Railway bridge over the Flint river, east of Reynold's Station.

(Section.)

1. Orange loamy sand passing into.....12 feet.
2. Water-worn quartz gravel, mostly under $1\frac{1}{4}$ inches in diameter10 feet.

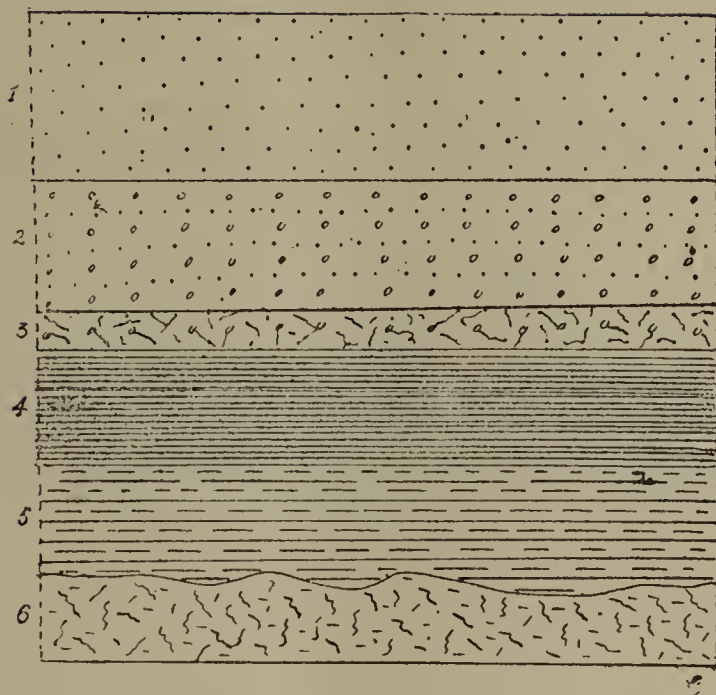


FIGURE 5.

- | | |
|---|---------|
| 3. Light blue clay..... | 3 feet. |
| 4. Banded clay..... | 4 feet. |
| 5. Red and white banded sand, resting unconformably on..... | 6 feet. |
| 6. Purple clay (with eroded surface exposed)..... | 6 feet. |

The beds Nos. 3, 4 and 5 probably belong to the Eutaw series.

The only other exposure of Cretaceous deposits seen along the Flint river is at a point about two miles below Everett's Station, where there is an important bluff showing the following beds in descending order :

- | | |
|---|--------------|
| 1. Orange loam..... | 8 feet. |
| 2. Bluish white clay, with irregular joints stained red..... | 6 feet. |
| 3. Orange and gray clayey sand, with unconformable base on..... | 5 to 9 feet |
| 4. Rough, whitish blue clay, surface and base both unconformable..... | 6 to 3 feet. |
| 5. Orange stained rounded quartz gravel..... | 10 feet. |
| 6. Coarse, cross-bedded white sand, with argillaceous binding, exposed..... | 4 feet. |

The lower three members of this section are Cretaceous and probably belong to the Eutaw series. For nearly a mile the bluffs expose these materials, and the dip is apparently not over twenty-five

or thirty feet per mile. The springs flowing through the lower gravel and sands have excavated several horseshoe recesses into these almost vertical bluffs. No attempt has so far been made to determine, in this meridian, the southern limit of the Eutaw series; nor, indeed, to trace its southern boundary hence, across the country to the Chattahoochee river.

Along the Chattahoochee river the Ripley formation extends from Broken Arrow Bend to Fitzsimmons' Landing, thus occupying a belt of about twelve miles. The assumed dip of this formation has been taken at about thirty feet per mile towards the south-southeast, and consequently the thickness closely agrees with Mr. Langdon's estimate of 385 feet. Hence, it will be seen that there is no great change in the volume of the Eutaw, in passing from Alabama to Georgia.

THE ROTTEN LIMESTONE SERIES.

This is one of the most pronounced formations of the Cretaceous series in Alabama, and is composed of impure limestones, at times merging into calcareous clay. In places, it contains an abundance of fossils. The limestones form marked bluffs along some of the Alabama rivers. The series has a thickness estimated at 1,000 feet. But along the Chattahoochee river, this great calcareous formation is absent, or at most, cannot be represented by more than an insignificant development of mechanical deposits, not yet identified.

THE RIPLEY SERIES.

Succeeding the more or less incoherent and prevailing sands of the Eutaw formation, there is an enormous thickness of impure, clayey sands or sand clays, often micaceous, and in some places of dark and in other localities of light color. Many of the layers are traversed by ledges of indurated rocky matter of similar composition, weathering into bold relief. Other beds of similar appearance are highly calcareous, from the occurrence of an abundance of fossil remains, which are occasionally preserved intact. Some of these deposits form considerable beds of calcareous marl, but none of them assume the condition of limestones. The marls are often highly phosphatic, as indeed some of the sands, which are occasionally glauconitic. Generally speaking, the sands are not incoherent, and contain enough calcareous or argillaceous matter to render them compact. Some of the sands are hardened into sandstones. Occasional gravel deposits assume the form of conglomerate. The general character of these beds is harder and more argillaceous than the materials of the under-

lying Eutaw formation. This aggregation of fossiliferous beds, containing upper Cretaceous fossils, has been named the Ripley series.

Along the Chattahoochee river, the Ripley series commences below Fitzsimmons' Landing, and the lower beds are composed of indurated, gray, calcareous, sandy clays, with intercalated bands, containing ball-like concretions. These deposits form bold, steep banks, into which the streams sometimes wear recesses. Such is the general character of the bluffs from Fitzsimmons' Landing to near Florence, a direct distance of eight or nine miles, although by river, more than twice as far. Whilst these beds dip gently to the south, yet they are frequently brought to view again by return dips, thus producing gentle anticlinals and synclinals. At many places, species of *Exogyra* are found, as these are the most common fossils. At the bend in the river at Patterson's, below Cottonton Landing, an abundance of large *Exogyra* was obtained. In some localities, the shells are not preserved in a perfect state, but yet are recognizable. Those clayey deposits of the lower portion of the Ripley are succeeded above Florence by more sandy strata, which are often concretionary.

At Rood's Upper Bend, a short distance above Roanoak, there is a most favorable bluff for the collection of fossils. Here is a section of marl, sand and clay, greenish gray clay, glauconitic sand and shell marl, forming an exposure of beds more than thirty feet in thickness. Of these layers, the glauconitic sand occurs near the centre of the series and has a thickness of about ten feet. When the indurated sands weather, quantities of fucoidal stems and coprolitic masses are found upon the hillside. In the lower beds, quantities of the teeth of shark, and the teeth and plates probably of reptiles, and fragments of lignite occur. The shell marl of the upper portion of the section is composed of a mass of decomposed shells of numerous species, with phosphatic nodules and occasional pieces of lignitized wood.

About a quarter of a mile below the fossiliferous bluff, there is a bed of oysters of gigantic size, the species of which have not been determined.

From this point for several miles, to near the mouth of Cowikee creek, the steep bluffs consist of light gray or green stained sands, indurated with calcareous or clayey matter. These somewhat hardened beds are followed by less coherent, impure sands. About six miles above Georgetown, just below the mouth of Soapstone creek, Stewart's Bluff rises to a height of 265 feet above the river. The lower 145 feet of this hill, is composed of Cretaceous strata; those exposed being dark green micaceous adhering sands. The Cretaceous beds are again shown opposite Georgetown in the Eufaula Bluffs, where the dark gray calcareous sands contain ledges of concretionary boulders of harder materials. Some of these strata are fossiliferous and descend to the water's edge, appearing at Burnett's Landing, on

the Georgia side of the river. Here were found quantities of *Exogyra costata* and the large shells of *Gryphæa mutabilis*. Below this point follows a succession of gray yellow sands, occasionally calcareous or argillaceous, and with sometimes indurated layers. Some of the beds contain Ripley shells and lignitized wood. Such were found in the argillaceous sands at the mouth of Pataula creek. Farther down the river, there is a ledge of sand, hardened into sandstone and containing *Exogyra costata* and *Echinoids*. This last bed is seen at the surface, for a considerable distance, owing to the return dips. The Echinoids are most abundant at the mouth of a small branch cascading over the sandstone, a short distance above Otho, Alabama. Just below the last named exposure, upon the Alabama side, at a point where the stream falls over a high bluff, there is a dark sandy micaceous and bituminous clay, in which friable fossils are delicately preserved, amongst which was a beautiful specimen of *Ammonites*. This bed is overlaid by a stratum of shell marl, containing numerous fossils, which is best seen upon the Georgia side, nearly opposite to this fall. The clayey sands containing *Exogyra* were found for two or three miles below Otho. Over these beds succeed coarse conglomerate, followed by a few feet of massive blue clay, which, at a point a little above Sandy Creek, Clay county, has been accepted by the joint surveys, as a summit of the Ripley series, and indeed, of the Cretaceous system.

The breadth of the country, underlaid by the Ripley strata, is thus shown to extend from near Fitzsimmons' Landing to near Sandy creek, a direct distance of about forty miles, but this river section is somewhat oblique, and thus, the direct distance, from Fitzsimmons Landing to its margin in Randolph county, is reduced to about thirty miles. In some places, the dip of the formation exceeds fifty or sixty feet per mile, but in such cases the amount is reduced by the return dip, so that probably thirty feet per mile will not be much below the average dip along the river; although it may somewhat reduce the estimated thickness adopted by the joint surveys, which have placed it at 1,080 feet.

Within the limits of Georgia, fossiliferous Ripley beds are found along the Pataula creek. In the gorges of the deeply cut branches, between Pineville and Cusseta, the argillaceous sands were found to contain *Exogyra costata*, and one valve of *Gryphæa mutabilis* was obtained.

Overlying the Ripley series, as just defined, there is a coarse, cohesive sandstone, six feet thick, above which occurs a bed of *Ostrea* limestone forming an easily traceable feature. The assigned age of the limestone is Lower Eocene. By means of this fossiliferous formation the base of the Eocene has been traced, by the writer, across Georgia to the bluffs along Flint river at Montezuma, thus, the south-

eastern limit of the Cretaceous formations, has been approximately carried seventy-five miles across Georgia, although the surface exposures did not always favor its exploration; being composed of but slightly coherent materials overlaid by superficial loams, which cover alike the higher lands and occupy the more ancient valleys, excavated in the Cretaceous strata, by the streams whose modern phases have not re-excavated the earlier valleys.

GENERAL NOTES ON THE CRETACEOUS SYSTEM.

The southeastern limit of the Cretaceous system has now been found to extend from a point near Sandy creek to Pumpkin Town, in the northern portion of Randolph county, and from there to a point about two miles south of Preston, on Mr. Cole's farm. Thence the line may be drawn to Mr. Carter's farm, at the old post-office of Quebec, on the boundary of Sumter and Schley counties, and from there to the base of the bluffs on the Flint river above Montezuma.

In this preliminary survey, the writer's efforts were devoted to the question of obtaining, provisionally, the approximate distribution and general characteristics of the greater formations in Southwest Georgia, and only incidentally to recording the local variations; hence, no attempt was made to separate the boundary between the Eutaw and Ripley formations, nor to obtain their relative development, which, at best, would be difficult.

From the survey of the Cretaceous system, it is found to have an area, west of the meridian of Knoxville, of two thousand square miles, with an estimated thickness, along the Chattahoochee river, adopted by the joint surveys, of 1,645 feet, if the Tuscaloosa series be included. Eastward of that meridian, the Cretaceous strata are known to still have a great depth, for in the deepest well at Fort Valley, over a thousand feet of deposits were penetrated. Beneath the superficial covering of loam, etc., probably most of the materials met with were Cretaceous; and, at the depth named, the well was found to be in Cretaceous sands. The records of a shallower well were preserved by Mayor Houser, and are thus given:

1. Red clay.....	20 feet
2. Yellow sand, with occasional layers of coarse white sand with argillaceous binding,.....	75 feet
3. White quicksand with a little water.....	10 feet
4. Clays of different colors with some sand.....	85 feet
5. Quicksand with a little water.....	10 feet
6. Laminations of clay and sand.....	95 feet
7. Quicksand.....	20 feet
8. Clay and sand of variable colors.....	170 feet
9. Quicksand.....	15 feet
Total.....	500 feet

In the deeper well, it was found that a stratum at three hundred feet was water-bearing, but the water did not rise higher than eighteen feet below the surface.

East of the Flint river, the Cretaceous system shrinks to narrow proportions, as the Lower Eocene limestones trend more toward the north, after crossing the Flint river.

The bearing of the rocks upon the topography is illustrated along the Flint valley, in the northern portion of Crawford county, where the river, in the different phases of its history, excavated out of incoherent materials; a valley now represented by swampy lands from two to four miles wide; whilst, further down, this broad character was checked by the more coherent Cretaceous and still harder Tertiary strata.

Upon the more plain like surface of the Cretaceous country, and in the broader depressions, the Cretaceous deposits are capped by loams of the Lafayette series, partly derived from the underlying materials. This source is apparent, for, in the country overlying the more argillaceous Ripley beds, the covering consists of heavier loam or clay, whilst over the more arenaceous beds of the Eutaw and Tuscaloosa series, the superficial covering is more sandy. Many of the Ripley beds are rich in marl and phosphatic material, and, hence, a richer superficial loam is found than where the same is derived from the less calcareous beds farther north. In the deeper valleys of the Cretaceous country, beds of those clays are directly exposed, which are apt to produce bad roads in wet seasons; but this characteristic is confined to a limited area. The relation of the soils is connected with the study of the superficial formation, and will be considered on subsequent pages.

The question of the availability of marls, green sands and phosphatic beds, for local use, must be left for more detailed exploration, because such beds, although of considerable extent along the Chattahoochee, as at Rood's Bend, and near the top of the system, are covered with superficial materials; but they have not been visited in the interior of the country, during the explorations of the few months spent, in the first steps of a geological survey—the determination of geological boundaries and their characteristics.

Many of the beds are characterized as water-bearing, and several artesian wells have been successfully obtained in the upper portion of the Ripley series. But the relationship of these deposits and the domestic water supply will be considered in a subsequent chapter.

In the future study of the historical relations of the members of the Cretaceous system, the following localities are pointed out as the most favorable for obtaining evidence from the fossil remains:

Broken Arrow Bend and shoals, Alabama side; the river bluffs at Fort Mitchell; Chimney Bluff, Georgia (both for fossil plants and shells); Patterson's Bend, below Cottonton; Rood's Upper Bend

above Roanoak; shoals and bluff at Barnett's Landing, Georgia, a few miles below Georgetown; near the mouth of Pataula creek; in the sandstones a short distance above Otho, Alabama, and in the neighboring bluff, over which a high falls cascades, and in the shell marl of the nearly opposite bluff in Georgia. But there are many other localities where Cretaceous fossils are found. Considerable collections have been obtained, but a report upon them cannot be made at this early date of the survey,

Owing to the general scarcity of fossils in the lower members of the Cretaceous formation and absence of marked lithological differences, the specialization of the divisions has been rendered somewhat difficult.

THE PHYSICAL GEOGRAPHY OF THE CRETACEOUS PERIOD.

The physical geography of Georgia during the Cretaceous period presented a marked contrast to that of the preceding eras, when the Archæan rocks formed the rounded shores of the southeastern part of the continent, now represented by Middle Georgia. These lands were low rolling plains, into which the rivers had carved their valleys down to the base level of erosion, and the meteoric agents had moulded the topography into the soft rounded contours. These conditions obtained far southward of the line which now marks their boundary, until the subsidence of the land brought the oceanic waters to the fall line between Columbus and Knoxville, where new shores of the Tuscaloosa formations commenced their growth in the shallow waters. The deposition of the materials appears to have been greatly disturbed by currents, as shown in the cross-bedding of the sands. The conditions were unfavorable to the development of marine life, the remains of which are not found in these accumulations in Georgia. Throughout the Eutaw epoch, similar conditions also prevailed, forming mechanical deposits, still more disturbed by changing currents, which destroyed the continuity of individual strata, and did not favor the assortment of the sediments respectively into beds of clays and sands. But the conditions were somewhat more favorable for the extension of marine life. The work of the currents is also seen in the quantity of the drift wood, which is now found lignitized, and scattered through the series. These varying conditions may probably have been effected to no little extent by the struggle between the Atlantic and the Gulf waves meeting upon the battle ground of Georgia and eastern Alabama; which struggle somewhat ceased in Alabama during the Rotten Limestone epoch, when the deeper and less disturbed waters permitted the formation of heavy calcareous beds, to the depth of one thousand feet, over the subsiding sea floor. But, in Georgia, the lands appear to have been elevated, or only slightly depressed and stationary, so as not to per-

mit of the extension of the limestones from the Gulf to the Atlantic side of the continent. During the succeeding Ripley epoch, southwestern Georgia appears to have been the dumping ground of the superficial sweepings brought down the Chattahoochee valley—the great river of this portion of the continent. Thus the mechanical sediments began to extend from the older rounded margin of the continent in a tongue-like projection, between the Gulf and the Atlantic basins, anticipating the extension of the Floridian peninsula.

Whilst the mechanical deposits underwent local variations, they extended farther eastward, than is now represented by their exposure as surface formations; but whether they maintain their thickness far southward beneath the Tertiary deposits can only be revealed by borings. But the probability, that they underlie all the superficial formations in Georgia cannot be doubted, although they may be diminished in magnitude.

CHAPTER IV.

THE CENOZOIC OR TERTIARY GROUP.

THE SUCCESSIVE SYSTEMS.

For thirty or forty years some knowledge of the southern Tertiary deposits has been accumulating, but Dr. E. W. Hilgard has the credit of working into order such deposits in the Gulf extension of the Mississippi valley. To this systematic work are to be added the labors of Dr. E. A. Smith, Mr. L. C. Johnson, and Mr. D. W. Langdon, officers of the Alabama and United States Geological Surveys. As the development in Alabama passes, to some extent, into Georgia, it becomes necessary to take the former as a starting point for the surveys in Georgia. In the brochure of Messrs. E. A. Smith and L. C. Johnson, the general development of the Eocene Tertiary, in the interior of Alabama, is given as follows in descending order:

SYSTEM.	SERIES.	
Upper Eocene.....	White Limestone.	<div style="display: inline-block; vertical-align: middle;">{</div> <div style="display: inline-block; vertical-align: middle;"> Salt Mountain..... 150 ft. Vicksburg..... 140 ft. Jackson..... 60 ft. </div>
Middle Eocene, Claiborne.....	Buhrstone (Siliceous).....	<div style="display: inline-block; vertical-align: middle;">{</div> <div style="display: inline-block; vertical-align: middle;"> 145 ft. 300 ft. </div>
Lower Eocene.....	Lignitic ..	<div style="display: inline-block; vertical-align: middle;">{</div> <div style="display: inline-block; vertical-align: middle;"> Hachetigbee..... 175 ft. Bashi..... 85 ft. Tuscahoma..... 140 ft. Nanafalia 200 ft. Matthew's Landing and Naheola130-150 Black Bluff..... 100 ft. Midway or Clayton. 25 ft. </div>

In the southern part of Georgia, the lower members of the Miocene system succeed the Eocene beds.

Owing to the frequent and strong lithological contrasts in the strata of the Tertiary formations and the outcropping of hard calcareous beds, as characterisitic features, the survey of the geological accumulations has been facilitated. Although the general surface of

the country is overlaid by superficial deposits, yet the harder calcareous beds rise to the surface at numerous points, which would not be marked if the beds were made of incoherent fragmental materials.

The first systematic work of any importance bearing on the Tertiary beds of Georgia was made by Mr. W. D. Langdon when he first surveyed the Chattahoochee river. This river was again resurveyed by the same gentleman, in company with Prof. E. A. Smith, State Geologist of Alabama; Mr. L. C. Johnson, Geologist of the United States Geological Survey, and the writer, as State Geologist of Georgia. The general geological section along the Chattahoochee river is thus seen in descending order:

SYSTEM.	SERIES.	THICKNESS IN FEET.
Upper Eocene....	White Limestone. Vicksburg and Jackson.	310, 500*
Middle Eocene...	Claiborne... ..	72, 240†
	Buhrstone	164
Lower Eocene.....	Lignitic.....	{
	Hachetigbee.....	10
	Bashi.. ..	44
	Tuscahoma.....	173
	Nanafalia.....	175
	Matthew's Landing and Naheola	} Wanting
	Black Bluff	
	Midway or Clayton.....	216(?)

Comparing this last section with the general section in Alabama, it will be seen that there is an important gap in the lower portion of the Eocene system. From more recent information, it is found that the estimate of the White Limestone series was much too small, for from the lithological evidence in the well at Bainbridge, the thickness of the members of the Eocene; from the middle Buhrstone upward to near the top of the White Limestone, ought to be increased from 405 to 750 feet without quite reaching the summit of the series. But part of the difference in estimate may arise from the thickening of the limestone in proceeding eastward; for as already shown, some of the Cretaceous formations are thicker in Georgia than further westward, whilst others are thinner. Other probable changes in thickness, in passing from the west to the east, will be noted.

The estimated thickness of the Eocene in Alabama, as shown from the above table, appears to be 1,690 feet, whilst in Georgia, with the members of the system differently developed, the thickness does not exceed 1,500 feet, by actual estimate; but to this, it may be necessary to add another fifty or one hundred feet before reaching the ex-

* Spencer.

† Spencer.

treme upper limit of the series southeast of Bainbridge. The calcareous development of the Upper Eocene, in Georgia, when compared with its development in Alabama, seems to be the reverse of the conditions of the Cretaceous period, when the calcareous deposits were more largely developed in that State. From the difficulty in identifying individual beds over widely separated areas, it is not always easy to ascertain with accuracy, the dip of the various strata; but from as careful an identification, as possible, of the base of the calcareous members of the Buhrstone, shown along the Chattahoochee and revealed in the artesian wells at Bainbridge and Albany, at their ascertained elevations as to sea level, the writer has trigonometrically determined the mean dip of the Middle and Upper Eocene of South Georgia, at twenty feet per mile, in directions south, thirty degrees east. This calculated dip, if extended to the whole Eocene formation, would reduce the above estimated thickness by an amount from 100 to 200 feet. But this calculated dip cannot be applied to the lower zone of fragmental deposit, which makes up the greater mass of the Lower Eocene rocks along the northern margin, in Southwest Georgia; where the dip of this portion of the formation is taken at twenty-five feet per mile, in the same general direction as the overlying beds. Still, this dip may become exaggerated, which general result is reduced by return dips, thus producing a series of local undulations. Local variations in thickness are more pronounced in deposits of fragmentary materials than in the calcareous matter.

THE EOCENE SYSTEM.

THE LOWER EOCENE OR LIGNITIC SERIES.

Overlying the Cretaceous system along the Chattahoochee river, there are about 600 feet of strata named long ago by Dr. E. W. Hilgard—the Lignitic series, for, in the Gulf States farther west, the formation is characterized by this carbonaceous mineral. Whilst these beds of Lignite become less numerous or almost disappear, in passing eastward, yet portions of the series are found in considerable thickness in Georgia. The greater part of these formations along the Chattahoochee river, is made up of laminated, grey sandy clays, in portions of which the sand predominates and is sometimes cross-bedded. Sometimes the sands are cemented into sandstones by calcareous matter washed out of the marly beds, giving rise to indurated ledges and protruding concretions. The clays are only occasionally tough argillaceous beds, as they frequently contain so much sand as almost constitute beds of quicksand. Such is consequently, the

name applied by artesian well-borers to the materials brought out in process of sinking wells through much of the Lower Eocene formations. Still, there are some harder clay beds. At the base, and near the top of this group of deposits, there are limestones, calcareous sands and marly beds, which serve as land marks.

The Lower Eocene beds form steep bluffs along the rapidly scouring waters of the Chattahoochee river; with the different series having characteristic features; each with its own peculiar *fauna*, which has led to their separation into seven divisions given in the above table.

In Alabama, the lowest or Clayton division, is a calcareous formation of insignificant development, but it reaches considerable proportions in Georgia, and is one of the most conspicuous features of the Lower Eocene system. Its surface has been found eroded, and consequently, there is a gap in the geological succession and the absence of two of the Alabama divisions represented there by 250 feet of sediments. Owing to the impressions upon the topographic features, the lowest or Clayton division, will be considered separately in Georgia. The succeeding divisions will be considered as a unit, except by describing the well-exposed sections along the Chattahoochee river.

MIDWAY (CLAYTON) DIVISION.

Along the Chattahoochee river, the contact beds of the Cretaceous and Eocene systems was not observed, but a bed of coarse-grained, almost conglomeritic incoherent sandstone was taken as the base of the latter. Succeeding this sand, there is a bed of yellowish white siliceous limestone containing a large *Ostrea* (probably *O. alabamensis*), a small *Ostrea*, and several other fossils. It forms steep bluffs, rising from ten to twenty feet above the water, into which numerous caverns recede. This rock commences at a point, about five miles north of Fort Gaines, near the mouth of Sandy creek, and continues for a considerable distance along the river. It is succeeded by white calcareous clayey sand, irregularly indurated, and containing obscure casts of shells. My estimated thickness of this last bed places it at about 135 feet. This indurated bed forms the base of the bluff at Fort Gaines, and weathers into yellow sand. Its surface is eroded, in places, to a depth of ten feet, and is overlaid by succeeding strata. The meaning of this unconformity will be explained later on.

The limestone of this formation is the first of marked lithological difference from the materials of the underlying Cretaceous, though many of the succeeding Eocene beds bear a strong resemblance to those of the older system. Consequently, the limestones form a feat-

ure traceable across the country. They underlie a belt of country, about five miles wide, the surface of which, though deeply covered with superficial deposits, is somewhat characterized by lime-sinks, often forming ponds.

From the Chattahoochee river, trending northeastward, the limestones occasionally penetrate through the superficial accumulations and produce bluffs rising to 25 feet or more above adjacent streams, and along the Flint river form the lower portion of a much higher escarpment. This mostly buried escarpment faces the northwestward. In the northern part of Randolph county, it forms the exposures at Greer's Cave, near Pumpkin Town, where the fossiliferous limestones are about 25 feet thick and form a bluff along a little branch. This locality has a wide local reputation on account of the presence of two caves of considerable size. South of Greer's Mansion (Pumpkin Town) the rocks are crossed by the Cuthbert road.

The individual beds of Clayton limestone reach as much as six feet in thickness and are compact and hard. Other layers, especially near the summit, are incoherent marly beds, full of fossils, especially a small *Ostrea*, *Pecten*, etc. The same species of *Ostrea*, characteristic of this limestone, is also found in northern Randolph. These beds of calcareous material reach a thickness of 30 feet. The elevation of the formation at this point is about 150 feet above that along the Chattahoochee river, and, hence, if for no other reason, the northern frontier would have a northeastward trend.

On Mr. G. W. Cole's farm, about two miles south of Preston, the Clayton limestone forms a bluff rising about 25 feet above an adjacent branch. From this locality characteristic fossils were obtained.

The northern boundary of the formation continues northeastward and appears on the farm of Mr. J. T. Carter, near the old post-office of Quebec, on the southern boundary of Schley county, where an exceptionally rich accumulation of fossils occurs. In the neighboring wash-out, the underlying coarse conglomeritic sand was found beneath the Oyster zone.

From this locality the formation trends northeastward to the Flint river, generally with bluffs up on the western side, and reappears on the eastern in the bluffs north of Montezuma. On the western side of the river, at Montezuma wagon bridge, there is a flinty sandstone which belongs to the base. In the limestones at Montezuma, there are many large pockets almost entirely made up of large *Ostrea* shells, the fillings of which have sometimes been weathered out, leaving the rock full of cavities. One of the upper layers of this massive limestone is composed of incoherent masses of shells of several species, amongst which a small decomposed *Ostrea* predominates. The whole forms a valuable friable marl. The calcareous beds rise to about forty feet above the river, in the bluff, which is best exposed

about two miles above the wagon bridge over the Flint river. This limestone seems to vary somewhat in thickness, which may be taken at an average of twenty feet.

The overlying calcareous sands are, lithologically, nearly related to the loosely coherent rocks of the Lower Lignitic group and should be considered with them over the interior of Georgia.

NANAFALIA DIVISION.

After an unconformity or gap in the geological succession, as shown at Fort Gaines, which will be a subject of later consideration, the next deposits in the geological column are those of the Nanafalia divisions.

The bluff at Fort Gaines, which is 125 feet above the river, shows the following well exposed section in descending order:

SECTION.

1. Red loam with rounded gravel at base.....20 feet.
2. Loose, grayish sand.....15 feet.
3. Coarse green glauconitic and gray calcareous clayey sand, with indurated ledges near base containing fossils; *Ostrea compressirostra*, cast of *Venicardia planicosta*, small *Pecten*, etc.....10 feet.
4. Dark gray argillaceous sand, full of decomposed shells..... 8 feet.
5. Ledges of white calcareous concretions with coarse sand containing shell casts..... 2 feet.
6. Coarse micaceous white sand with pebbles, cross-bedded... 5 feet.
7. Sandy gray clay with indurated ledges, some of which contain decomposed shells.....12 feet.
8. Sandy clay with shell casts of hard texture, resembling pseudo-buhrstone 6 feet.
9. Coarse white sand..... 4 feet.
10. Dark gray laminated clays with *Gryphæa thirsæ*.....15 feet.
11. Indurated ledge of glauconitic sand..... 8 feet.
12. Yellowish sand containing numerous *Gryphæa thirsæ*, *Venicardia planicosta*, *Crassatella tumidula* and some *Ostrea compressirostra*.4 to 10 feet.

The peculiarly characteristic fossil of this division is *Gryphæa thirsæ*; still, the general *facies* of the formation has its own individuality.

Overlying these beds at Fort Gaines, higher strata are exposed in

the bluffs, for a distance of about four miles. These are composed of somewhat fossiliferous gray sandy clays with indurated layers. The whole thickness of the division is placed at 175 feet.

TUSCAHOOMA (BELL'S LANDING) DIVISION.

Succeeding the Midway division there are about 173 feet of light and gray sandy clays, containing lines of concretions. These beds have so far yielded no fossils, except the upper three feet. Some of the sandy members are probably glauconitic. These sediments extend to about one mile above the mouth of Yantayabba creek, Alabama.

BASHI (WOOD'S BLUFF) DIVISION.

Just above the mouth of the Yantayabba creek, along the bluffs of the Chattahoochee, there is a narrow belt of sands with indurated edges, laminated clays, and, beneath, there are about 18 feet of fossiliferous sandy marl hardened into limestones of a light yellow color, the whole forming a thickness of about 44 feet, which have been referred to the Bashi Division, which is one of the landmarks of the Lignitic series. In its typical form there is a large amount of included green sand. The marl is apt to be indurated by calcareous matter into concretionary masses. This division is characterized by lignite beds, which, farther west, reach important proportions. Such are also found east of the Chattahoochee river in some of the artesian well-borings. Thus the limestone and the lignite make the lithological features conspicuous.

Lignitic matter is found in beds at several horizons throughout this section.

HATCHETIGBEE DIVISION.

The upper portion of the bluff, at the mouth of the Yantayabba creek, consists of gray and cream colored lignitic sands and calcareous sandy clays, having a thickness of about ten feet. These materials Mr. Langdon refers to the Hatchetigbee Division, which, farther west than Alabama, reaches a thickness of 175 feet.

GENERAL NOTES ON THE LOWER EOCENE.

Along the Flint river, there are very few places where the waters flow near the bluffs which bound the valleys, and fewer still where they have exposed to view the sections of the incoherent materials of the Middle Eocene or Lignitic series.

Just below the mouth of Camper creek, the following section appears:

1. The red or orange loam, passing into8 feet.
2. Layer of quartz pebbles on an unconformable bed.....4 feet.
3. Gray and yellow laminated sands..... 8 feet.
4. Yellow laminated sandy clay.....12 feet.

Only the lower twenty feet of this section belong to Eocene deposits. Further down the same bluff, the orange loam has a thickness of twenty feet and rests unconformably upon a laminated blue clay, under which is a bed of sand. At a point about nine miles, direct (18 miles by water), below the Oglethorpe-Montezuma railway bridge, at the bend where a steamer was sunk, there is a bluff on the western side of the bend, showing an excellent section.

1. Orange loam.....2 to 6 feet.
2. Gray, sandy clay, surface and base irregular.....6 to 1 feet.
3. White sand, undulating.....2 to 6 feet.
4. Gray clayey sand.....3 feet.
5. Dark purple laminated sand, exposed.....2 feet.

In this section, only the three lower members belong with certainty to the Lower Eocene series.

At the mouth of Mountain (?) creek on the western side of the Flint river, there is a conspicuous bluff showing exposures of Eocene sediment.

1. Orange loam (superficial).....variable.
2. Gray clay..... 6 feet.
3. Dark, purplish, laminated, sandy clay12 feet.
4. White clay, exposed..... 10 feet.

All these beds dip at from 50 to 80 feet per mile towards the southeast. This is the last exposure of laminated mechanical deposits belonging to the Lower Eocene exposed along the Flint river. The next bluffs are those of limestone forming the conspicuous feature above Danville.

Thus, it will be seen that between the base of the Eocene formation, at Montezuma, and the limestones belonging to the middle Eocene at Danville, the rarity of exposures of Eocene formations renders the determination of a continuous section of those deposits impossible. Yet, at extreme low water, it is possible or even prob-

able, that more exposures might be met with. Fossils were not obtained, and therefore, in the sections given, the exact division to which each of them belongs has not been determined. But the more southern section above given has a general resemblance to the Bashi series, and in location it was found where that formation might be looked for, and consequently, the locality is placed as the southern limit of the Lower Eocene.

Along the road, between Oglethorpe and Americus, where it crosses Sweetwater valley, a whitish coarse sand, cemented with clay, occurs. This, too, lies near the upper portion of the Lower Eocene. Lower Eocene sands are also found at the base of the remarkable bluff, at Bluffton, in Clay county. About two miles southwest of Pumpkin Town, in a washout beneath a heavy covering of red loam, there is found a coarse white argillaceous sand and in the bottom of the ravine a yellowish white pipe clay. About five miles north of Cuthbert, on the road to Pumpkin Town, there is a white clay beneath the orange loam covering; this probably belongs to the upper Midway or Clayton division.

Other evidences of the lower Eocene are found at several points revealed by artesian wells. These will be considered later; but especial attention is called to the section shown in the artesian well at Americus.

The total breadth of the Lower Eocene system, along the Flint river, does not exceed eleven or twelve miles, but in the western part of the State it has a width of fourteen miles, and in the diagonal section, along the Chattahoochee river, the direct distance is about seventeen miles. As may be seen from the table (page 42), the total thickness of the Lignitic series along the Chattahoochee river is taken at 618 feet, which is probably the maximum in western Georgia, as the belt appears to diminish towards the northeast. As has been already noted, there is a hiatus in the Lignitic series along the Chattahoochee river. One of the absent divisions is characterized farther west by phosphatic beds. The physical history of the gap will be noted at the close of the chapter on the Eocene system. The Lower Eocene has yielded valuable materials for the superficial deposits which form the soils of this portion of Georgia. The sandy beds form some of the most important water-bearing formations of the south. At Cuthbert, the soft Lower Eocene (Midway) limestone is quarried for building purposes with good results.

MIDDLE EOCENE SERIES.

BUHRSTONE DIVISION.

This division of the Middle Eocene system, in the Gulf States, was founded on lithological grounds, being distinguished as the siliceous portion, whilst the overlying Claiborne represents the calcareous beds

of the series. These different formations represent epochs of very dissimilar conditions. But upon palæontological evidence, there is no sufficient reason for their separation, as shown by Dr. Hilgard and Dr. Smith. The lithological name, unlike those of other members of the Eocene system of geographic origin based upon typical localities, has objections, as it raises a popular idea of a succession of a certain economic mineral which is not confined to a single horizon; and only to a limited extent do such hard quartzitic, flinty, porous rocks contribute to the mass. The characteristic materials of this division, as given by Messrs. Smith and Johnson, consist of gray or light argillaceous sandstones, often glauconitic, with numerous concretions of pure clay, traversed by streaks of oxide of iron; indurated white clay, light and easily broken; hard, coarse-grained glauconitic sandstone; yellowish and streaked hard siliceous and aluminous sandstone; and white siliceous, almost quartzitic rock associated with the hard siliceous sandstone. These more flinty deposits, similar to buhrstone, occur near the base of the series. The most abundant materials are the indurated clays and argillaceous sandstones.

Along the Chattahoochee river, there is a succession of formations which are correlated with the Buhrstone of Alabama. These consist of a similar development of white fossiliferous sand, succeeded by heavy developments (from 40 to 50 feet each) of coarse, cream colored aluminous rocks, sandy in places, and light green sand with small *Ostrea sellaeformis*; and at the top of the division, cream colored siliceous slightly calcareous rocks in hard and soft layers, forming projecting ledges, seldom more than two feet thick. At an angle in the river, about four miles due south of Yantayabba creek, there is a ledge on the west side, rich in *Ostrea divaricata*, *Anomia*, etc.

The estimated thickness of this deposit is 164 feet, and it extends from the mouth of the Yantayabba to the island at the mouth of Omussee creek, near Columbia, Alabama—a direct distance of about eight miles. This formation was crossed at only one or two points, except along the river. No distinctive features were seen along the Flint river. The hills above Americus appear to be capped by the lower members of the division, which have furnished the fossiliferous fragments or blocks, to the overlying superficial materials. In the railway cut, about three miles from Americus, on the road to Preston, there is an excellent exposure of a white rock having the appearance of decayed limestone with resulting residuary sandy clays, charged with great irregular boulders of fossiliferous and porous hard quartzose rock, or buhrstone rock. The fossils have not yet been examined, but from the lithological character and the geographical position, they are here placed as belonging to this division of the Middle Eocene. The surface of the water-works' wells, at Americus, is over 100 feet below the above described rocks, capping the adjacent hills and covered with rocks of the Buhrstone division; hence, the materials brought to light in the borings belong to the

Lower Eocene. The boundary line between the Buhrstone and the overlying Claiborne has not been determined across Southwestern Georgia, but it is shown in the bluffs along the Flint river, above Danville.

THE CLAIBORNE DIVISION.

This Eocene series, so well known on account of its rich fauna, forms a feature along the Chattahoochee river, but differs somewhat in its development in Alabama and Georgia; in one particular, the the more highly fossiliferous upper portion has not been found along the Chattahoochee. In Alabama, this upper portion consists of ferruginous, or where not weathered, somewhat glauconitic sand. Beneath the Upper Claiborne division in Alabama, there are some sixty feet of calcareous clays and sands, characterized by great quantities of *Ostrea sellæformis* which strongly marks this horizon. Below this horizon there are fifty more feet of sandy and clayey beds, which are often glauconitic.

Along the Chattahoochee; the Middle Claiborne beds are those most wide-spread, and are also those principally developed. Here, they are composed of alternate beds of indurated and soft marl, and, of white and yellowish-white sandy limestone, the softer strata of which are rather aluminous. The hardest strata weather out into "root-like shapes," whilst the softer recede beneath the overhanging ledges, by which the dip of the strata is rendered conspicuous. The dip often reaches several degrees, but, in returning, the beds are frequently brought again to the surface, thus reducing the general average and spreading the limestones over a broad belt of country. The projecting ledges extend throughout the formation. The *Ostrea sellæformis* is most favorably preserved in the hard ledges at the junction with the softer. Abundance of small shells of the same species occur in many localities, whilst the larger varieties are more commonly found in pockets. The calcareous bluffs of the Claiborne series extend from the island at the mouth of the Omussee (near Columbia), the surface of which is covered by a bed, rich in large varieties of the characteristic shell—to a point opposite and below Gordon, Ala., and there passes beneath the next formation, which appears at the Midland Railway bridge. Thus the formation has a breadth of about twelve miles, with a calculated thickness of about 240 feet, though this is greatly in excess of Mr. Langdon's estimate, which has been generally adopted by joint surveys. For, at that time, the data from the wells in Georgia had not been collected.

Along the Flint river, the Claiborne beds are well marked; commencing in the bluff just above the old Danville ferry. This bluff is over half a mile long and is composed of alternate layers of hard and soft sandy limestones, with beds as much as four feet thick, the softer beds having more marly and clayey appearance. The rock

is of a greenish or yellowish white color; its surface weathers into somewhat rough, but hardly jagged forms, which are so characteristic of certain beds of an overlying cherty formation. These Claiborne beds are well characterized by *Ostrea sellæformis*, which are most abundant at the base of and in the harder ledges. In these bluffs, the limestones rise to somewhat over twenty feet above the water, and they are capped by an equal thickness of superficial sands and loams.

Above and below the mouth of Ebenezer creek, upon the left bank, excellent exposures occur in steep bluffs rising to fifteen or twenty feet above high water. Here, the beds appear for considerable distances as quite horizontal, but again suddenly bend down at steep angles, which are followed by a return dip, thus producing undulations. The hard ledges stand out in bold relief, and the softer have a clay-like appearance. In some of the beds, these harder layers form the larger proportions of the mass; in others but a small proportion. The softer beds appear at Shell Bluff and again at Warwick. The last important exposures of these rocks were seen in the bluff on the right bank of the river upon the southern side of the Great Bend, a short distance above the new railway bridge, between Albany and Cordele. The bluff rises twenty feet above high water, and extends for nearly two miles. The texture of the different layers is less varied than in the lower portion of the series, but the face is largely worn into small root-like protuberances. Occasional pronounced rostra or platforms stand out in graceful projection over the waters. These bluffs are carved into recesses by many springs flowing through subterranean passes, which occasionally open beneath the surface of the river, discharging pools of clear water in the otherwise muddy current. The locality is taken as the southern limit of the Claiborne series, which limit may have to be somewhat modified by the palæontological evidences. Still, about four miles above this point, on the top of the bluffs upon the eastern side of the river, there are some flinty, fossiliferous rocks belonging to a higher formation. These, although farther north along the river, are also farther eastward, and probably indicate an irregular outline for the boundary of the formation. Accepting this provisional boundary, its breadth reaches about twenty miles in the meridional direction, or from twelve to fourteen miles directly across the zone.

Along the Muckalee and Kinchafoonee creeks, bluffs of Claiborne limestones and marls appear, but these have not been sufficiently explored. At many points throughout the Claiborne belt, the limestones appear near the surface, as for instance, near Leary's, at Morgan, in the bed of the creek at the Corday mill, (which is near the northern limit) and other places; but future investigations may somewhat vary the assigned boundary of the Claiborne zone between the

exposures on the Chattahoochee and the Flint, yet the width, as indicated will probably be found to extend across the western part of the State.

Several wells have been bored through the Middle Eocene formation, and the information derived therefrom has been used in constructing the provisional map. If the lithological identifications at Albany be correctly made, the thickness of the formation will not materially vary from that assumed from the calculated dip of the formation in Southwest Georgia, or a thickness of two hundred and forty feet.

UPPER EOCENE SERIES.

WHITE LIMESTONE SERIES.

Under this title, all the remaining Eocene formations of Georgia are included. These consist of beds of limestones, varying somewhat in character and in fauna; but the characteristics, so far determined, do not point to sufficient grounds for subdivision. This grouping in Georgia is made to include the long known Jackson and Vickburg divisions of the more western Gulf States.

The rocks of the lower part of the series are light colored, argillaceous limestones, with some layers of purer calcareous material. This horizon is characterized by the sea urchins—*Scutella lyelli*, and a smaller species, and *Pecten perplanus*, etc. This section has an estimated thickness of twenty-five feet, and occurs at the Alabama Midland Railway bridge, over the Chattahoochee river, in the southern part of Early county. This is the horizon of the *Zeuglodon cestoides*, a sea monster, seventy feet long, in structure between a whale and a seal.

The middle portion of the White Limestone is largely a hard crystalline and locally siliceous limestone, weathering into irregular vesicular masses, left from the solution of the calcareous matter of the fossiliferous and highly siliceous portions of the limestone. Some portions of the White Limestone are soft with an earthy appearance, and can be used for building purposes, hardening on exposure. This division of the White Limestone is especially characterized by *Orbitoides mantelli*, which often fills the mass of rock with their disks; hence, the name of Orbitoidal limestones.

Along the Chattahoochee river, this limestone continues from the Midland Railway bridge to Mariam Landing, in Decatur county; south of which locality the Chattahoochee banks are unfavorable for their exposure. But a few miles eastward, these rocks appear in a bluff at the bend of the Flint river, near the mouth of Fowlstown swamp, which exposures are also the most southern seen along this river.

The Flint river enters the zone of the White Limestone near the mouth of Jones' creek, and continues therein to the point just referred to, six miles southwest of Bainbridge.

Near the mouth of Jones' creek and a little below, at Cotton Bluff, in Lee county, boulders of hard silicified vesicular rock rise out of the soft, earthy, rotten looking limestone. The vesicles have the appearance of cavities formerly occupied by sponges, from one to two inches in diameter. At the latter place, numerous fucoidal and coprolitic masses, an inch in diameter are weathered out; these may be phosphatic.

At the mouth of Pine Wood's creek, the earthy limestone, containing a few fossils (polyzoa and small corals) form a bar extending into the river. At the rapids, about five miles, in a direct line, northeast of Albany, on the western side of the river, there are huge boulders of siliceous rock resting on the chalky limestone. From the mouth of Kinchafoonee creek, the vesicular limestones form the surface of rock exposure. At Albany, we find the same superficial rock associated with the more earthy. About two miles below Albany, there is the first locality seen, where the limestones form both bluffs of the river, showing the reducing of the base-level of erosion. Opposite the mouth of Dry creek, is Goat Island, beyond which there is a huge pile of scoriaceous fossiliferous boulders,—the bluffs whence they came having been otherwise entirely removed by erosion. This condition is represented in a photograph. Such boulder heaps, often forming islands, are characteristic of many points above the mouth of the Ichawaynochaway (one of which near this was photographed). From this point down to the mouth of Fowltown Swamp, such superficial vesicular masses, as have been described, are occasionally found upon the surface of the limestones; having originated from the solution of the calcareous matter of the siliceous limestones.

Other exposures of the White Limestones have been examined in Decatur county, notably near Blowing cave, where a stream cascades into a bowl 60 feet in diameter and 40 or 50 feet deep, with vertical walls of the White Limestone of the more earthy type. A section of about 90 feet of these rocks is exposed at Forest Falls, a lime-sink already noted on page 20 of this report. The rock throughout is largely of the earthy type without any important development of the silicified pockets so often shown along the Flint river. In this chalky limestone, fossils are not well preserved, but *Orbitoides* was found.

At Bainbridge, a well was sunk through this formation, the record of which is given me in descending order:

SECTION.

1. Sand and clayey sand.....75 feet.
2. Limestone ; the upper 200 feet the softer ; no clayey layers 700 feet.
3. Soft limestone.....50 feet.
4. Quicksand to bottom of well.....75 feet.

A second well was sunk, within three feet of the first, which penetrated, below the limestone, to a depth of 425 feet in quicksand. Shark's teeth, lignite and pyrite concretions came from some of the layers of the sand. Several cavities in the limestones were passed through ; the deepest being three feet.

The thickness of the White Limestone formation is here placed at 500 feet. From 700 feet of harder limestones shown in the Bainbridge well. 240 feet have been deducted as belonging to the Claiborne series ; corresponding to the thickness derived from the mean dip of the Middle and Upper Eocene in Southwest Georgia. To the remaining 450 feet, assumed as the White Limestone, 40 feet more have been added, for Bainbridge is a short distance north of the boundary of the formation, as it crosses Decatur county. This thickness is in harmony with the average dip of the system. The whole belt has a breadth of 25 to 28 miles.

GENERAL NOTES UPON THE MIDDLE AND UPPER EOCENE SERIES.

The rivers and streams which flow through the country, are more or less characterized by bold bluffs. Over this country, there is also an extensive development of lime-sinks, often occupied by swamps or lakes, as the outlets to these depressions often become filled. Many of these lakes are evenescent, the waters occasionally sweeping away the materials damming the subterranean outlets. Another striking physical characteristic of this country is the absence of the numerous small streams which appear elsewhere in Southwest Georgia. This arises from the drainage of the region by subterranean outlets that, in part, find their way to the larger rivers.

The country underlaid by the Buhrstone formation is often moulded into prominent hills and valleys. That above the Claiborne becomes flatter but yet rolling ; but the country overlying the White Limestone series is remarkably level.

The effect of the limestone upon the soil will be considered later. Some of the more marly beds will be found to be of value to agriculturists. The purer beds of limestone will prove useful in building purposes. But the full local value of these materials cannot be announced, as the country has been surveyed only along a few lines, in order to approximately determine the boundaries of the different zones ; and local conditions are constantly varying their availability.

RICH HILL.

Rich Hill, six miles southeast of Knoxville, belongs to an outlying district not yet geologically correlated with the sections in Southwest Georgia, but as it contains some Eocene rocks, a record of it is here appended, as shown in the following section :

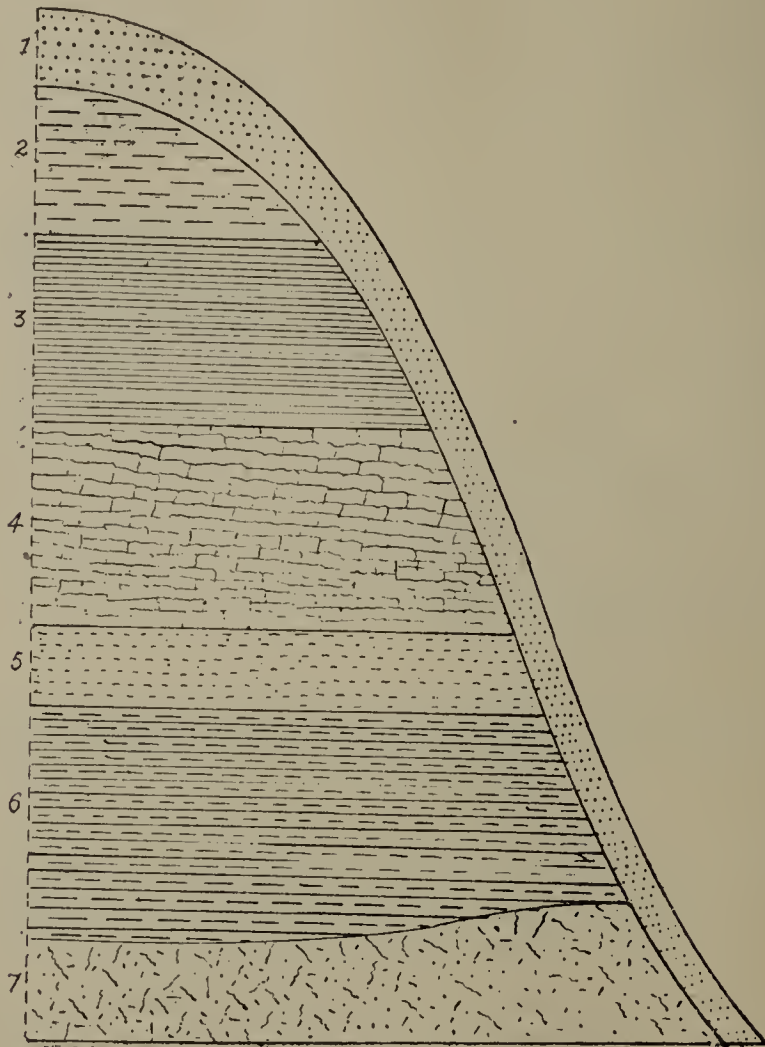


FIGURE 6.

1. Orange or red loam unconformable, on..... 10 feet.
2. Laminated colored sands with clay partings;..... 20 feet.
3. Grayish white compact clay..... 25 feet.
4. Sandy limestones; the lower beds separated by beds of red
sand; contains echini, sharks' teeth, etc..... 25 feet.
5. Light colored gray sand..... 10 feet.
6. Pure white sand..... 30 feet.
7. White clay with surface eroded..... 10-15 feet.

CHAPTER V.

THE MIOCENE SYSTEM.

Along the Chattahoochee river, succeeding the White Limestone, there is a series of argillaceous, sandy limestone forming the "Chattahoochee series," thus named by Mr. Langdon. Succeeding this formation is the Alum Bluff series, a highly fossiliferous Middle Miocene sand. These formations extend some distance into Florida. The Chattahoochee series, however, underlies a considerable area of the southwestern portion of Decatur county. It is well developed in the extreme southwestern corner. On the road from the steamboat landing, leading to the village of Chattahoochee, 70 feet of this whitish soft, highly argillaceous, sandy limestone, are shown along the lower portion of the bluff, which rises into the terrace 175 feet above the river. This formation probably extends much higher in the terrace, but it is concealed by the mantle of orange loam. This deposit, when wet, becomes plastic, but when dry it crumbles more or less. The formation is thus described by its author: "Argillaceous and sandy limestone, alternating with strata of purer character; it contains a *Pecten*, an *Ostrea* very closely related to our *Virginica*." We also found the remains of *Decapods*, and Mr. Johnson and myself found fragments of vertebrate remains. The railway cuts adjacent to Chattahoochee afford several good exposures.

A mile west of Recovery Station, the same deposits are found, with the lower portions consisting of the softer sandy marl, and the upper of more solid limestone. At this point, there are some picturesque sinks. Overlying these deposits, there is a whitish, coarse, clayey sand of which only the upper ten feet are exposed. This deposit is correlated with the limestones as part of the Chattahoochee series. These white clayey sands are well exposed at the base of the railway cut on the road to Bainbridge, about one mile west of Climax. This section will be given in a succeeding chapter.

Similar white sandy clays and clayey sands extend to eastward of the meridian of Cairo, beneath a belt of 15 miles or more in width. They were seen at several localities between Mr. R. A. Connell's farm, four miles northeast of Whigham, and the mouth of the Attapulgis creek, in one direction; and near the mouth of Tired creek in another. These materials are popularly called pipe clay, some layers having an excess of sand, others forming a plastic clay. Numerous

wells are sunk into these deposits, which will not stand as a firm wall, like the overlying orange loam. The wells require to be curbed. Near the Attapulcus creek, just north of the boundary line of Florida, on the farm of Hon. W. E. Smith, the more calcareous beds of the Chattahoochee series were seen along some of the branches. Overlying these deposits, as shown in the railway cuts near Whigham, darker colored Tertiary sands and clays were seen; but the subdivision belt to which they belong has not been determined.

On Ponto creek and adjacent streams, near the Floridian boundary, westward of the Ochlockonee river, soft marly limestones were found, having a depth of more than 25 feet. These resemble in appearance those at Recovery. A medium sized *Ostrea*, *Pecten* and other fossils were found in them. They give rise to lime-sinks along the State boundary. Passing northward from Ponto creek, some six miles from Florida, on the Cairo road and adjacent to Tired creek, extensive exposures occur where a fossiliferous silicified limestone forms a prominent feature. Fragments of this stone also occur in the superficial materials of the district, thus showing that it is a subjacent formation. About four miles southeast of Cairo, on Mr. McCrone's farm, and in the valley of Provor's creek, similar silicified rocks are found. These were formerly quarried for millstones. This belt trends northeastward, towards Ochlockonee post-office. Eastward of this zone, at Thomasville, there are 162 feet of clays and sands revealed in the artesian well; only the upper portion of these belongs to the superficial covering of the country. A few miles eastward of Thomasville, there is another belt of fossiliferous limestone; these rocks are well shown in the sink on Mr. Braswell's farm about six miles southeast of Thomasville. Rocks are seen at several points, as at the phosphate beds west of Boston; and several miles farther northwestward of Patten post-office. This zone is characterized by lime sinks such as those southwest of Boston and those of Dry and Round Lakes north of Boston.

Eastward of this belt, there is another Miocene series of sandy clays containing poorly preserved remains of a large oyster. These are seen about four miles southeast of Boston.

Farther eastward, or southeastward, there is a zone, near the Piscola creek, characterized by a brecciated siliceous rock, with opal like characters, and slightly phosphatic. This is seen on the farm of Mr. Cutler, and is said to extend northeastward of Quitman.

Beneath the superficial covering of this country, the boundary lines of the different zones of these Miocene rocks have not yet been determined.

In this preliminary report, no complete effort has been made to work out their full relations, by the fossils. But from the Miocene beds along the Chattahoochee river, and from the Miocene character of the

fossils along the phosphatic belt east of Thomasville, determined for me by Dr. W. H. Dall, and from their stratigraphic relations, it appears that the greater portion of southern Decatur, and all of Thomas county, are underlaid by members of the Miocene system. The thickness is not determinable as yet. It exceeds 400 feet, and will probably be found very much greater, when the whole region is investigated, unless the Miocene deposits shall have been found repeated by return dips, or by the presence of islands within their belt.

GENERAL NOTES ON THE MIOCENE SYSTEM.

The country underlaid by these deposits in Decatur and Thomas counties is generally a high, rolling plain into which the streams are carved to a limited extent. A zone of lime-sinks crosses the Miocene belt in the eastern part of Thomas county.

There is a marked difference in the soil, although less so in appearance, between this region and that of the White Limestone to the north. The phosphate beds are related to the rocks of this formation, but will form a separate subject; as also the water-supply, and the favorable climatic character of this portion of Georgia.

THE PHYSICAL GEOGRAPHY OF THE CENOZOIC PERIOD.

At the close of the Cretaceous period, the muddy shallow waters were replaced by a clearer and somewhat deeper sea, favorable for the growth of organic life, which resulted in the formation of the calcareous rocks of the Midway epoch; later, there was a re-emergence, and finally an elevation of the land of Southwest Georgia, although not of Central Alabama, where the Midway subsidence had not reached the proportions shown in Georgia. This epoch of elevated land was marked by rivers, the carving of the newly elevated plains, and the forming of valleys. This condition prevailed through two short epochs, recorded in Central Alabama by the formation of a few hundred feet of sands and sandy clay. The evidence of this elevation is preserved at Fort Gaines, where there is an unconformity in the beds (first discovered by Mr. Langdon), and the absence of the two divisions referred to. The remaining portion of the early Eocene period was characterized by shallow seas and swamps, wherein lignite was formed. But these lignite-producing swamps prevailed to a greater extent in the western Gulf States than in the eastern, and diminished to small proportions in Southwest Georgia, where they appear to have been replaced by the shallow seas building up the shores of Georgia.

The middle and later Eocene period was characterized by deeper

waters than the Lower Eocene epoch, and more favorable conditions for the development of nearly eight hundred feet of limestone.

The Miocene period commenced with a shallowing of the waters marked by more sandy coast lines supporting an extensive marine fauna. But as far as our scanty information goes, the period was marked by one of terrestrial oscillations in Southwest Georgia.

Eocene formations reappear in Northern Florida, where it is probable that during the Miocene period, the older portions of that State formed an island (as first suggested by Mr. L. C. Johnson) between which and the mainland of Georgia, there was a broad strait being slowly filled up with deposits of Miocene age, now underlying portions of Decatur and Thomas counties. But the end of the Miocene period is not recorded in Southwest Georgia.

CHAPTER VI.

PLIOCENE AND PLEISTOCENE SYSTEMS.

COLUMBIA SERIES.

LAFAYETTE SERIES.

Spreading out as mantles over the whole Southwest Georgia, there are deposits of orange or red sandy clays or loams, massive and laminated sands, with local gravel deposits, and occasional lighter colored clays. Whilst the older formations succeed each other and underlie successive zones or belts of country, these superficial deposits cover all of the older strata from the Miocene deposits, on the Floridian boundary, to the base of the Cretaceous, and, indeed, overlap the edge of the crystalline rocks along the fall line between Columbus and Knoxville. The range of altitude throughout which these accumulations extend reaches from elevations of eight hundred feet above the sea, down to, and occupying, the lowest valleys at less than one hundred feet, in the section of the State under consideration.

Two distinct formations are recognizable in these superficial accumulations. To Prof. E. W. Hilgard belongs the honor of commencing their study, long ago, in Mississippi. Equal credit is due to Mr. W. J. McGee, who has carried his investigations from the Potomac river to the Mississippi, and discovered the relationship between these deposits in the Atlantic States with those in the Gulf region. For the lower series, the terms *Orange Sand* (Safford and Hilgard), and the *Appomattox* (McGee), became incorporated in geological literature. The results of recent conferences have led to the adoption of Prof. Hilgard's name of Lafayette (from a typical Mississippi locality), and the final abandonment of both the other terms. The upper series is named the Columbia (from the typical locality in the District of Columbia), by Mr. McGee, who has carried his investigations over a wide territory. This explanation is given here, because the nomenclature, involving changes, has only been recently settled.

These accumulations form to-day some of the most interesting series of geological records in the Southern States. They constitute the soils of Southwest Georgia. Nor are these deposits simple, for they rest on the old sculptured surfaces of the land, occupying older valleys excavated alike out of the Cretaceous, Eocene and Miocene formations, and often entirely obliterate the ancient

smaller water-courses. The lower of these materials have their own surfaces eroded and are covered by the higher accumulations of the series. These materials, in Georgia, have been studied in part by Professor J. E. Willett, Mr. W. J. McGee and the writer, as shown in their published papers, but the history is not as yet wholly explained, for the records are incomplete.

The superficial deposits in Southern Georgia, are quite distinct in character from the underlying Tertiary and Cretaceous beds, and mark distinct physical conditions of accumulations, which were similar in both the Lafayette and Columbia epochs.

The data for the determination of the exact age of the Lafayette series is not known. It unconformably overlies the Middle Miocene formations, and again it unconformably underlies the Columbia beds, which are assigned to the Pleistocene periods. The Columbia series is correlated with the lowest Pleistocene deposits of the north, by Mr. W. J. McGee, who accordingly assigns the underlying Lafayette to some epoch of the Pliocene or the later Miocene period. Upon the present evidence, I am unprepared to accept this conclusion; because of the close geological resemblance of the Lafayette series to the Columbia, and its dissimilarity to the underlying Tertiary formations; and because high continental elevations generally characterized the Pliocene period. In harmony with Mr. McGee's conclusions as to the identity of the Columbia accumulations, with those of the lowest known drift of the North, it may be hypothesized that the Pleistocene period commenced earlier in the South than in the North, leaving its records in the Lafayette deposits. This suggestion would conform to the idea of Dr. G. M. Dawson, that there were alternating continental conditions between the Pacific coast regions and the northwestern plains, during the Pleistocene period.

Provisionally, I place the Lafayette and Columbia series together, and give the following local descriptions without regard to their somewhat unsettled age, and their local differentiation. The Columbia series shows also two divisions, the latter confined to the valleys.

THE LAFAYETTE AND COLUMBIA MANTLES IN THE FLINT VALLEY.

At Fair Play Hill, two and one-half miles north of Knoxville, capping the ridge, there is a deep red sandy loam, containing small rounded pebbles, of which a thickness of ten feet is exposed. This point is one of interest, as being at or near the most northern limit of the belt, and at an elevation of about eight hundred feet above the sea. At Rich Hill (see figure 6 on page 56), about six miles southeast of Knoxville, the same red loam forms a capping at an elevation of 835 (?) feet; and near by, gravel is seen on the hills at fifty feet below. At both these localities, the loam forms a capping for both the

surface and the sides of the hills, where the underlying formations were incised by former eroding streams. This condition is common to the formation, as it forms a sheet alike over the ancient hills and greater valleys. The base of this loam, especialy in the vicinity of the greater rivers, passes into a well marked bed of rounded quartz gravel, sometimes three inches in length. Such gravel is seen upon the hills between Knoxville and the Flint river, at elevations of 130 feet above its modern high water. South of Knoxville the red loamy surface is replaced by a belt of loose gray sand.

The country south of this point is, commonly speaking, a high plain somewhat incised by streams. The surface is generally composed of the orange loam, which varies in thickness from zero to 20 feet, as shown in the railroad cuts south of Gaillard's. (See figs. 2, 3, 4, page 30.) At Fort Valley, this red loam or clay reaches a depth of 2 feet, as shown in the artesian well. About three miles south of Fort Valley, there is an excellent exposure in the railroad cut on the road to Americus.

1. Deep colored red loam or hard sandy clay, with rounded gravel
in the lower two feet, resting upon an eroded surface...6-10 feet.
2. White and red mottled clay with surface eroded.....7-3 feet
3. Thin laminated sand with clay partings.....2 feet.
4. Laminated sand, in colors from black to white, exposed.... .10 feet.

No. 1 represents our Lafayette deposit, and I am inclined to place even the lower members as belonging to an earlier episode of that period.

In a neighboring washout, the red loam has a thickness of ten feet, underlaid by beds of whitish clay from 4 inches to 2 feet thick, intercalated with sand beds. Some of these sands are deep red, and others gray or white; beneath the whole are white sands. This section reaches a total thickness of about 25 feet.

From Fort Valley southward, the level plateau is covered with the red loam of argillaceous texture. West of Winchester, sections of this superficial material are well shown, where about eight feet of orange clayey sand rests upon laminated sands in white and colored bands. Upon the higher plateau, above Montezuma, the red loams prevail; but in descending to the Flint valley, the underlying gray sands form the surface soils. This is true over the lower country about Montezuma, and, indeed, for many miles in the direction of Americus. But the higher hills are everywhere capped with the orange loam.

Along the Flint river, many sections of the Lafayette loam are seen forming the bottom lands. The best section, in its relation to other rocks, is shown about two miles south of the great bend, in the river in closest proximity to Everett station. That section is here given.

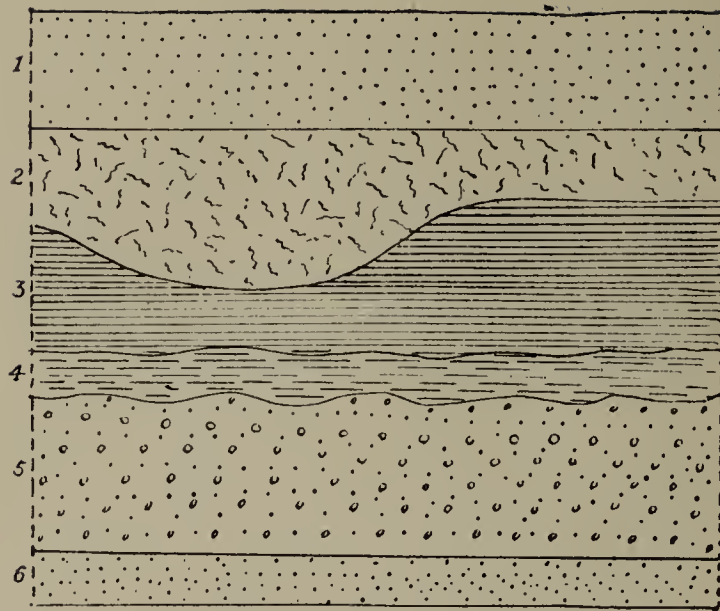


FIGURE 7.

1. Orange loam or sandy clay8 feet.
2. Light bluish clay with irregular joints stained red6 feet.
3. Orange and gray clayey sand, unconformable below5-9 feet.
4. Coarse light bluish clay, unconformable above and below3 feet.
5. Orange-colored quartz gravel, unconformable above10 feet.
6. Coarse white sand cemented with clay, exposed4 feet.

The upper three members and the fourth member represent two distinct episodes, as shown by the unconformity. At the ferry, between Winchester and Garden Valley, the mantle of orange loam is well developed, reaching from near the river to the surface of the country 210 feet above it, thus occupying alike the hill and the old valley. Here, the deposit is of a more sandy character than adjacent to Fort Valley, and the lower beds are cemented into occasional blocks of ferruginous sandstone.

At Oglethorpe, there is an exposure of coarse yellow and white sand interlaminated, into which there is a valley carved and refilled with clay, belonging, probably, to modern river overflows.

Just below the mouth of Camper creek, 12 feet of this formation appear, of which the lower portion is pebbly and rests upon gray and yellow sands. Where these superficial materials succeed the incoherent older formations, and where the exposures do not reveal unconformity, it becomes somewhat difficult to always distinguish the lower beds, which can be the more readily done where a limestone country marks the upper limit of the subjacent formations.

The limestone bluff above the old Danville ferry shows from 12 to 15 feet of orange-colored loam, traversed by an irregular layer of stones derived from the underlying rock. Beneath this loam ten feet

of yellow and white laminated sands occur. From this lithological relation there is but little difficulty in distinguishing the more sandy members of these surface deposits from the older Eocene. Just below the foot of this same bluff, occupying a valley excavated out of the original limestones, there is the following section :

1. Orange or red loam.....15-20 feet.
2. Layer of small boulders and pebbles.....1-2 feet.
5. Gray, white and yellow sand.....15 feet.

Between the railway bridge and Warwick, the orange loam is covered with three or four feet of washed gray sand. To a smaller extent this superficial sand occurs further up the river, and was there identified as a deposit from the overflow of the modern river. But, in descending the valley, this superficial dry gray sand becomes more and more pronounced, and at elevations far above the overflows of the gradually descending river; and hence, it is not a modern deposit; moreover, this sand in various places is seen to rest unconformably upon the orange loam deposits, and thus it belongs to the distinct Upper Columbia episode. It is this formation, or its equivalent, that forms the sandy plains of the lower Flint valley.

At the rapids, about five miles directly above Albany, Eocene limestone boulders occur in clayey deposits, which appear to graduate into the orange loam in one place, whilst overlying a coarse gray sand in another portion of the same bed. This exposure is remarkable, and reveals a condition rather difficult to explain—whether boulders could possibly have been moved by waves, or whether the clay and boulders are residual, and commingled only along the contact, with the overlying sandy clay, which was not deposited until after some coarse sand beds had been formed upon the side of the boulder bed. Near the mouth of Dry creek, many miles farther down the river, there is a repetition of these conditions just described. Near Detroit Post-office, the orange loam, with a thickness of from four to seven feet, is underlaid with laminated sands of different colors. Below the mouth of Pond creek the orange loam rests upon laminated clay, which is of the Lafayette series. About five miles further down the river we find the following section :

1. A surface of whitish or gray dry sand, resting unconformably upon.....2-6 feet.
2. Orange or red sandy loam, with eroded surface.7-1 feet.
3. Laminated sands of different colors.....7 feet.

This section, then, represents an actual unconformity between the superficial sand and the orange loam. This nonconformity is also displayed above Bogg's Ferry, by the superficial gray sand resting upon the eroded surface of the lower gray sand, without the intervention

of the orange loam. At an angle in the river, midway between Bogg's Ferry and the mouth of the Ichawaynochaway, there is a curious exposure. The rock is covered with a light bluish clay, succeeded by a whitish yellow and red mottled clay, in the top part of which there are boulders like the subjacent limestone. The top of this clay is eroded, and, covering the whole, there is a thick capping of the orange or red loam. Nearly opposite this last bank the light basal sand, overlying the limestones, is succeeded by a light blue clay, above which is the orange loam. The importance of this succession is, that occasionally the orange loam rests upon young clays, although it more commonly succeeds light colored sands along a considerable portion of the Flint river.

Whilst the high terrace plains in this region extend over the country far beyond the river margin, yet a few modern terraces are shown, marking the subsiding of the base level of the river erosion. Thus, near the mouth of the Ichawaynochaway, there are preserved three well marked modern terraces.

Below this point, there are many exposures of these superficial deposits generally characterized by the orange loam resting upon gray sand. Very commonly the loam is covered with a layer of gray sand from one to eight feet in thickness. This condition obtains to the last bluff seen along the Flint river, below Bainbridge. But one point, seven miles above Bainbridge—the Red Bluff—should be noticed. This is the face of a terraced plain rising fifty feet above the river. The orange loam upon one side of a washout has a thickness of twenty feet, upon the other thirty feet. Midway through it, there are irregular patches of light colored clay. A portion of the red deposit may be considered a sand. Below the sand there is a bluish irregularly jointed clay, beneath which the White Limestone occurs. The sand is cemented by iron so as to form a ferruginous sandstone.

LAFAYETTE AND COLUMBIA MANTLES IN THE CHATTAHOOCHEE VALLEY.

In the vicinity of Columbus, both the Lafayette and Columbia formations are best shown in the railway cut, and in the ravines upon the Alabama side of the river. The upper of these consists of about ten feet of red loam underlaid by from one to four feet of coarse gravel. This formation rests upon the eroded surface of the Tuscaloosa series. The Columbia series rests unconformably upon the older and constitutes the plains at Columbus, which rise about one hundred feet above the river and 260 feet above the sea. This later formation is made up of bluish sand and alluvial clay. About five miles south of Columbus, just beyond Upatoi creek, on the road to Cusseta, there are other fine exposures of the older deposits. (See figure 1, page 28.)

1. Orange loam,.....10 feet.
2. Laminated, colored sands with a streak of whitish clay ; this bed is completely cut through by the valley of an ancient branch about twenty feet wide, which is now filled with the overlying red or orange loam.....6 feet.
3. White and stained clayey coarse sand.....8 feet.
4. Gray sandy clay.....6 feet.

On neighboring hills, the gravels are found at an elevation of about 350 feet above the river, which is two or three miles distant.

At many points along the Chattahoochee river, this orange loam capping is characterized by drift logs at its base; these probably belong to the younger system of deposits, although sometimes of a different color from those at Columbus.

Steward's Hill, six miles north of Georgetown, displays the finest exposures of the Lafayette series seen anywhere in Georgia. This hill rises 265 feet above the river; the lower 145 feet belong to Cretaceous beds; the overlying 120 feet constitute the Lafayette sand or loam.

1. First bench of loamy sand, drab and reddish; the lower three inches cemented with iron.....30 feet.
2. Second bench, like the first, with sandstone cemented at base.....10 feet.
3. Ditto of a redder color, but at base there are three feet of sandy clay.....20 feet.
4. Variegated colored laminated clayey sands.....40 feet.
5. Ditto partially concealed.....20 feet.
6. Cretaceous deposits.....145 feet.

The lamination is not always well marked. The sands vary from white to red. Through one of the beds, there is a layer of coarse pellets, producing a fine conglomerate. In this region, the gravels occur along the sides of valleys tributary to the Chattahoochee, but are not found at Steward's Hill. The gravels appear to be characteristic of the plateau to which Columbus belongs. This condition is shown in the high terrace of Eufaula (125 feet above the river), where there is a thick gravel floor. That terrace is bounded on the west by hills covered with Lafayette loam. At Fort Gaines, a similar condition is found. The surface of the same terrace is covered with twenty feet of red clayey sand or loam, the lower part of which is composed of quartz gravel.

The railway cuts east of Georgetown expose excellent sections.

Along the river, about four miles above Columbia, Alabama, a fine exposure of orange loam was seen rising twenty or thirty feet above the river. In this loamy deposit, a piece of gneiss was found, in size 8x6x4 inches, and some smaller pieces of mica schist. These trans-

ported stones could not have been brought from a point nearer than Columbus, seventy-five miles distant in a straight line. They could not have been transported by waves, but were probably carried southward entangled in the roots of drift-wood. A smaller boulder was also found in the fine sands of Steward's Hill referred to above.

The terrace in the extreme southwestern corner of the State, near Chattahoochee village, has approximately the same altitude as at Columbus and Fort Gaines. Its surface and sides are covered, throughout a vertical range, of one hundred feet, with the same orange-colored sandy clay or loam.

From these descriptions, it will be seen that orange colored or red sandy loam extends throughout the whole length of the river from the highest altitudes of the country to the present flood plains. But there is also another series of superficial deposits, which rest unconformably, and at lower elevations, upon some of the red loams—the second bottoms.

LAFAYETTE AND COLUMBIA MANTLES IN THE INTERIOR OF SOUTH-WEST GEORGIA.

Throughout the highlands of Decatur and Thomas counties conditions similar to those along the great rivers prevail. Thus, near Whigham station we see the following section :

1. Orange or red loam passing beneath into a lighter and more clayey layer..... 4-8 feet.
2. Reddish and light colored mottled clayey sand with light patches of clay; only the upper portion is laminated; the lower part is somewhat sharply defined, and in other places apparently passes into..... 8 feet
- 3 Laminated white and purple clay with red micaceous and sandy partings. This bed shows undulations..... 3 feet.
4. Laminated red sand with clayey partings..... 6 feet.

No. 1 belongs to the Columbia and possibly to the No. 2 and No. 3 Lafayette series. In the Attapulgus creek district, the orange or red loam varies from two to eight feet, and often passes imperceptibly into bluer clay, which occasionally graduates into banded clay.

On the Thomasville road, nine miles east of Bainbridge, the orange loam is conspicuous. There, a rolling hill-country, covered with this red deposit, bounds the sand-covered plains of Bainbridge. In a washout, the lower portion of the loam, which is 8 or 10 feet thick, contains irregular pockets of cherty fragments derived from the adjacent rock. At one point, this loam rests upon blue clay. In some localities, this subjacent clay is seen; at others the underlying material is a quicksand. The explanation of this condition was not

obtained until the observation was made in the railway cut about a mile west of Climax, on the road to Bainbridge, showing the following section:

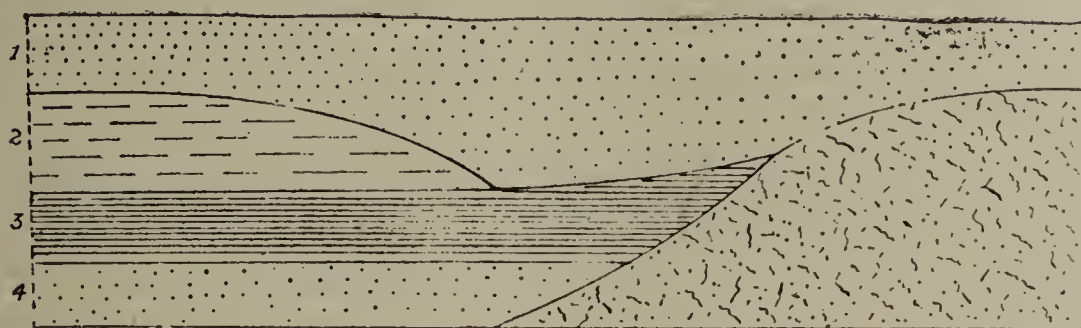


FIGURE 8.

1. Orange or red loam passing below into a red and white clayey material, with some ferruginous concretions... 4-12 feet.
2. Laminated sands, in colors from white to black, with clay film partings..... 0-12 feet.
At the west end of this section the sand is traversed by two seams of white clayey matter about 8 inches thick. It rests upon the eroded surface of
3. Whitish sandy clay.... 8-4 feet.
4. A band of sand from white to dark red in color, with some slightly clayey seams; exposed in places. 8 feet.
5. Miocene, white sandy clay, exposed..... 0-16 feet.

No. 2 is wanting at the eastern end of the cut, but No. 1 rests upon from 10 to 15 feet of a sandy clay (Miocene) No. 5 which is not exposed at the western end of the section. Two unconformable deposits succeed the Miocene; but the lower of the two is sometimes completely wanting. Thus is explained the occasional absence of the sand, which is so often seen beneath the loam; namely, on account of its entire removal by erosion, before the deposition of the superficial red loam.

In many places, in these southern counties, the orange loam rests directly upon the deposits of apparently Miocene age. On the higher lands, the loam is not covered by any superficial material, but at elevations inferior to 200 feet above the sea, a superficial water-washed sand (Columbia series) may be seen, at many places, resting upon the loam. This superficial sand, at the phosphate beds, west of Boston, has a depth of a foot and a half. Throughout the lower and more level counties of Mitchell, Miller, Baker, Dougherty and Calhoun, the loam is apt of itself to be sandy, and covered with a sandy soil, either directly derived from the loam, or perhaps indirectly by the waves acting temporarily in some lagoon, which may formerly have

covered these counties. This last explanation appears to be sustained by the presence of duny sand ridges rising to a height of twenty feet, on the east side of the Flint river, opposite Newton.

A further characteristic of this orange or red sandy clay or loam is that its lower portion consists of a bed of gravel, in the vicinity of the ancient valleys. Thus, on the hills, above the last bridge over the Upatoi creek, the gravel occurs at an elevation of 350 feet above the Chattahoochee river, which is two or three miles distant. These pebbles diminish in importance on going southward, and were not seen near the Floridian boundary. But, as if to take their place, fragments of limestone—or in phosphatic regions, pebbles of phosphate, occur in portions of the beds. In this way, the character of the subjacent rocks is detected by the hillocks being covered with such loose masses, secondarily derived from the drift.

As was noted before, at one or two points along the Chattahoochee, drift boulders, from the crystalline rocks far away, were found. The same holds true along the Flint and in other regions. This evidence of partial transportation of the material of the loam is not needed to explain its source; for it is generally so charged with hydrated micaceous particles as to at once tell that a considerable portion of it has been derived from the decayed crystalline rocks of Middle Georgia; which had also contained the quartz veins, whence the quartz pebbles, in the gravelly portions of the formation, originated. However, their partial local origin is attested by the presence in many localities of fragments of the subjacent rocks.

From the study of the sections given, and the general impression left by the investigation, there is seen to have been more than one episode of deposition; but the lithological character has a degree of uniformity from the fall line, between Columbus and Knoxville, to the Floridian boundary, although interrupted by the superficial sands in Macon, Marion, Muscogee and Chattahoochee counties, and by the more sandy surface of the country bounding the lower Flint river, so as to render the separation somewhat difficult. This is not to be wondered at, for the younger material was, to a large extent, only the older material redeposited. No fossils have been found in any of the beds, except drift-wood, seen along the base, in the Chattahoochee valley.

Whilst here referring to variation in character, it should be noted that the loam overlying the more clayey deposits of the Ripley series, is much more argillaceous, and contains a larger portion of ferruginous pellets than seen elsewhere.

The thickness of these loams may be placed, on the average, at twelve feet, although varying from zero to twenty. When the gravel is present, it may reach a thickness of ten feet, but rarely more than four. The sandy formations, underlying the loam, in Southern Geor-

gia, may also reach another twenty feet in thickness, but it is impossible, at the present juncture to give an average estimate. That these later deposits may have a considerable thickness, is shown at Steward's Hill, above Georgetown, where one hundred and twenty-five feet of the Lafayette series are exposed.

The whole question of surface deposits in south Georgia needs further investigation. Indeed, the disconnected details given in this chapter, are the result of the necessarily speedy preparation of this preliminary report without due time for the digestion, even of the facts which have been collected; and hence, the extraordinary length of this chapter, in which there has been an attempt to set forth the facts, in a condition for future use. A few words of explanation may, however, be given.

THE PHYSICAL GEOGRAPHY SUCCEEDING THE MIOCENE PERIOD.

In Southwest Georgia, there are no Miocene deposits known to be of more recent age, than those of the middle portion of the period. The Pliocene formations are also absent, unless the Lafayette series belongs to that period. Overlying, alike, all the formations in Southwest Georgia, the superficial deposits, described in this chapter, are found. Going outside of the region, we learn something more of the history of the country under consideration. As has been shown by the writer in "High Continental Elevation preceding the Pleistocene Period;"* and "Post Pleistocene Continental Subsidence,"† that the American continent stood at from 3,000 to 5,000 feet, or more, above its present elevation compared with the sea level. This high elevation occurred during the later Miocene or Pliocene period. In fact, the Pliocene period was one of general continental, elevation not only of America but also of Europe; for, there are but limited basins of Pliocene formations found above sea level. This question of elevation, for the southeastern part of the continent, is one which will form a future chapter in the writer's investigations.

During this high continental elevation the great rivers, such as the Chattahoochee and Flint, excavated valleys, out of the comparatively recent Cretaceous and Tertiary deposits, to depths of from 200 to 350 feet, sometimes with a breadth of several miles. Along the Flint valley, this erosion undermined and washed away the softer portions of the Upper Eocene limestone formations, whilst the harder rocks remained, often in accumulations of great, water-worn boulders, noted on a former page. Another result of the high continental elevation in Southwestern Georgia was the establishment of the extensive subterranean

*Bulletin Geol. Soc. Am., Vol. I., 1889,

†Ibid., Vol. II., 1890.

drainage, and the formation of caverns in the limestone, which are very extensive. Some of the limestones must have a depth of nearly 1,800 feet in Southwest Georgia (1,600 feet, at Thomasville, where Mr. Thompson reported caverns to have been found in the artesian well.)

Following this high continental elevation, there was an epoch of subsidence, when the oceanic waters covered Southwest Georgia and washed eminences now eight hundred feet above the sea, along the fall line near Knoxville. It was during this Lafayette subsidence that a portion of the loams and sands, described in this last chapter, were spread over Southwest Georgia. Again, the continent rose and the rivers remoulded the surface features, carving out new valleys. Another unequal subsidence (the Columbia), to probably a maximum depth of nearly three hundred feet, followed. During this second subsidence, which left Southwest Georgia partially covered, another formation was spread out over the plains of Columbus, Fort Gaines, and that plateau which characterizes the Chattahoochee river, and reached over the low counties of the Flint district. From the evidence along the Flint river, there appears to have been a temporary re-elevation to a limited extent, followed by a third partial depression, which caused the back waters of the rivers to spread over the low counties, probably forming the lagoons, in which were deposited the superficial soils of Miller, Mitchell, and Baker, and portions of other counties. This depression may not have exceeded one hundred feet, which would have permitted the slackened waters of the great rivers to overflow the low country.

CHAPTER VII.

ARTESIAN WELLS AND UNDERGROUND DRAINAGE.

A few tables of artesian wells have already been given, and from these records we have been able to extend our knowledge of the underlying formations. Most of the borings made have been the result of pure venture, and only occasionally have the records of the wells been kept. In the borings, it is easy to determine whether the drill be on a hard flinty rock, on a hard limestone rock, on a hard clay, or an incoherent sandy deposit. But when the earthy matter, being penetrated, consists of a succession of comparatively incoherent sands, clayey sands or sandy clays, or soft marly deposits, the recognition is not so easy. Moreover, by adopted methods of washing out the materials by stream of waters, these fine sediments are not so readily distinguishable, for the clay derived from clayey sands and the fine marly matter, alike render the overflowing water turbid, and obscures the included sand. To the well borers it has generally been of no interest to preserve records, which would have been invaluable to the survey. As an example of the want of geological knowledge, the following may be cited: The manager of a certain well said he expected to get water at a certain depth, which he calculated would reach the Albany water-bearing strata. When thus informed, I told him that he had been laboring in the dark, for already, geologically speaking, the well was far below the Albany strata. Other efforts have been made in Georgia to get deep artesian wells in the crystalline rocks, which would not have been undertaken with the advice of any experienced geologist. In all Southwest Georgia, I regard the question of domestic water-supply the most important economic question, and after that, the drainage of such portions as are subject to malarial conditions. Whilst much of the southwestern portion of the State is well drained and healthy, yet, the numerous ponds and occasional sloughs in the comparatively level country, are unwholesome. Immediately adjacent to the rivers, the overflows render the districts somewhat unhealthy. With the drainage of the ponds and sloughs, and with artesian water, there are few districts in Southwest Georgia which may not be rendered comparatively healthful in the future. Even such towns, as are situated near rivers subject to high waters, and that are now provided with artesian wells, have become healthful. Consequently, I have given primary consideration to this subject.

The following imperfect well-records have been of service to me in both the study of the underlying geological formations, and in the investigation of artesian water-supply:

BAINBRIDGE WELL.

See page 55.

THOMASVILLE WELL

This meagre record was furnished by Mr. E. O. Thompson, superintendent of the water-works. It is greatly to be regretted that the full record of this deep well was not preserved.

1. Red and blue clay and sands to..... 162 feet.
2. Limestone to..... 225 feet.
3. Shell rock with water at..... 310 feet.
4. Rubble rock at..... 360 feet.
5. Shell rock with a copious flow at..... 410 feet.
(From this level, water rises to within 210 feet of surface).
6. Water at..... 1,400 feet.
7. Bottom of limestone..... 1,680 feet.
8. Quicksand thence to..... 1,820 feet.

The water derived from 410 feet evidently comes from the Miocene deposits. The quicksand beneath, 1,680 feet, probably belongs to the Lignitic series. The water does not rise in the well higher than 210 feet below surface. This is not to be wondered at, for we have no land higher than the Thomasville ridge for a distance of more than 50 miles.

THE QUITMAN WELL.

The best record obtained was furnished by Mr. S. S. Roundtree:

1. Clay and sand to 70 feet.
2. Soft rock in seams..... 100 feet.
(Rock 3 feet, after which drill fell 6 feet into a stream of
water to)..... 109 feet.
3. Soft rock and sand, to..... 186 feet.
4. A hard flint rock..... thin layer.
5. Quicksand and hard rock in beds 1 to 3 feet thick to..... 300 feet.
6. Sand and clay to..... 340 feet.
7. Sand to..... 385 feet.

The water rose from the stream at 109 feet to within 30 feet of top of well. This water is artesian, and would probably be found perfectly satisfactory. The geology of this section has not been studied sufficiently to locate the horizon of the water more than being in Miocene beds.

JESSUP WELL.

Although outside of the district of this report, the record of this well will here be added, without criticism.

1. Sand to.....	10 feet.
2. Quicksand to	14 feet.
3. Yellow clay soil with layers of quicksand to.....	26 feet.
4. Quicksand to	52 feet.
5. Limestone to.	55 feet.
6. Quicksand to	65 feet.
7. Limestone to.....	78 feet.
8. Clay with sand to.....	233 feet.
9. Soft spongy rock to	237 feet.
10. Blue marl to.....	490 feet.
11. Water-bearing quicksand. Water rose to within 33 feet of top.	

CAMILLA WELL.

A well was sunk at Camilla to about 600 feet, when water was obtained, but not a flowing stream.

ALBANY WELL.

Several wells have been sunk at Albany and flowing water has been obtained. The record of one of these was furnished by Mr. Charles Tift, and also samples of boring; from several depths. This well has an elevation of about 20 feet above the railway station :

1. Surface soil and red clay to.....	23 feet.
2. Light clay, white sand; colored clays and white lime rock to.....	55 feet.
3. Flinty rock to.....	60 feet.
4. Limestone with clay seams to	315 feet.
5. Thick rock to.....	319 feet.
6. Quicksand with a rocky stratum at 440, and lignite just above rock, to.....	480 feet.
7. Blacksand	thin layer.
8. Blue marl strata to.....	678 feet.
9 Porous water-bearing beds to	732 feet.

Samples were taken and examined as follows: Marl at 26 feet; limestone at 40 feet; oölitic or coral sand from 110 to 115 feet; a lime-rock, 5 feet thick, at 160; gray rotten limestone from 180 to 200; shell rock at 310; shell marl at 315 to 320; lignite at 340; coarse quartz sand with chips of gray limestone, 350; shell limestone, 360; clean sharp white sand in different beds between 360 and 425; lignite at 440; green slightly calcareous fine sand, with a little clay between,

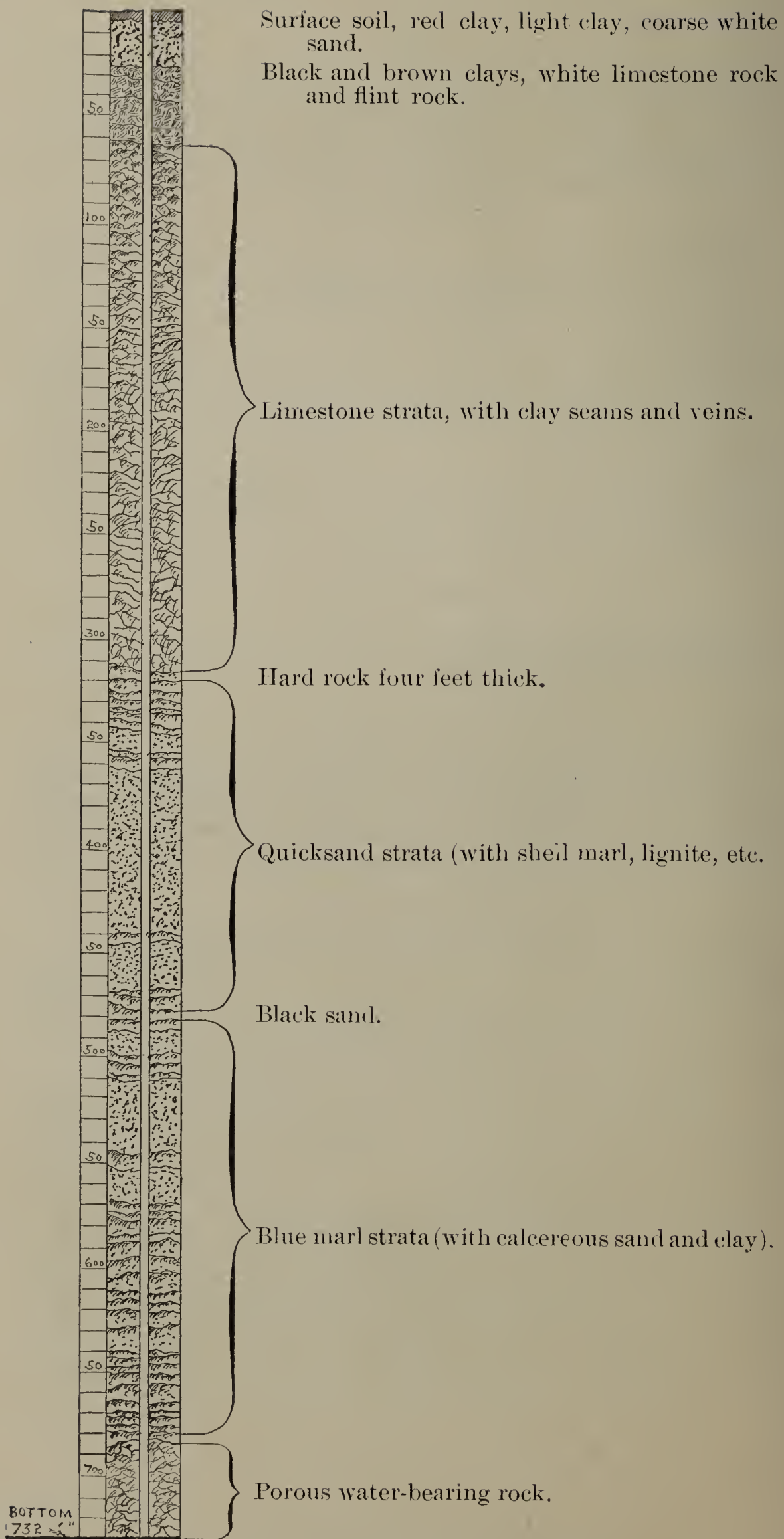


FIGURE 9. (MR. TIFT'S WELL AT ALBANY.)

435 and 678; a water-bearing coarse quartz sand, with calcareous particles, at 660.

The upper 320 feet represents the lower portion of the White Limestone and the whole of the Claiborne series. The next 40 feet most nearly resemble the harder beds of the Upper Buhrstone. Below this horizon, the well penetrates the Lower Buhrstone and passes into the middle or lower portion of the Lower Eocene formations. Part of the lignite beds are situated near the Bashi series. The records of this well have proved invaluable.

THE FORT WELL.

The first artesian well, in Southwest Georgia, was sunk by Mr. J. P. Fort, at a point about sixteen miles westward of Albany. The record of this well is thus given by Mr. Fort:

1. A few feet of surface clay, followed by limestone boulders to 65 feet.
2. Limestone, with silicified layers, containing shells and traversed by subterranean streams to.....150 feet.
3. Blue marl (clay ?) to165 feet.
4. Shell rock, sand, rock and marl (clay); water rose to within 14 feet of surface, to.....260 feet.
5. Sand tinted blue; a layer of very fine white sand at 370 feet; below which some coarse sand with shell fragments and sharks' teeth; to.....380 feet.
6. Blue clay and sand rock in alternate layers to.....410 feet.
7. Blue clay with soft sand rock to (flowing water).....490 feet.
8. Sand and clay forming water-bearing stratum to hard rock at.....530 feet.

This is a flowing well.

These two last wells, and that at Bainbridge furnish the most important records obtained. The water supply comes from the Lignitic or Lower Eocene series.

LEARY'S WELL.

A well was bored a depth of about 600 feet, but the records were not preserved. Water was obtained.

ARLINGTON WELL.

1. Chalky clay..... 20 feet.
2. Sand and white clay.....
3. Shell rock..... 5 feet.
4. Very coarse sand.....
5. Shell rock, etc., to.....355 feet.
6. Hard rock, siliceous, with soft places, to.....390 feet.
7. Hard dark clay.....500(?) feet.
8. Coarse, dry micaceous sand.....540 feet.

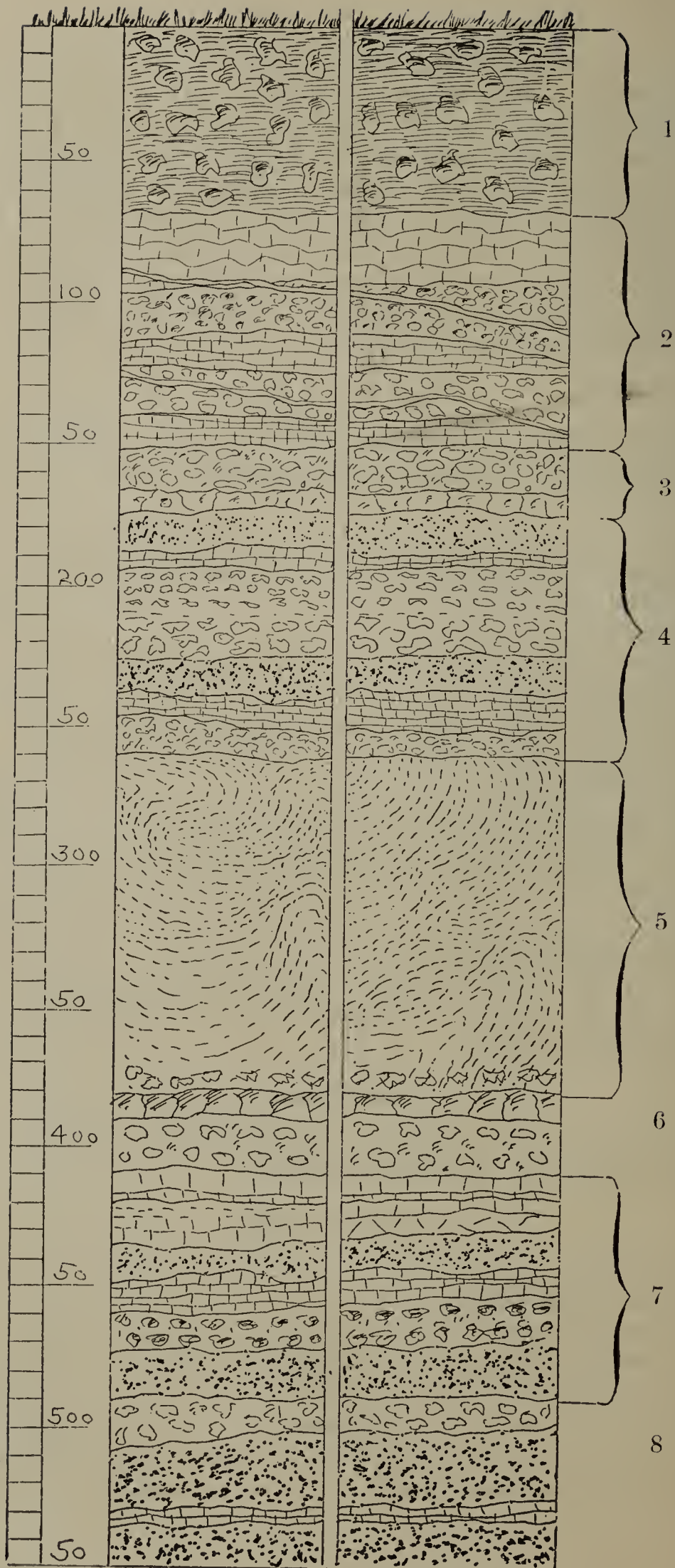


FIGURE 10—THE FORT WELL.

CORDELE WELL.

1. Soil, clay and chalk, about..... 40 feet.
2. Coarse red sand to..... 60 feet.
3. Loose boulder rock, through which the tubing was driven ;
fine, white sand was also found, to..... 68 feet.
4. Different colored marls (clays or true marls ?).....168 feet.
5. Limestone and shell rock, with an intervening layer of
sand, to.....400 feet.
6. Sand and shell rock to..... ..475 feet.
7. Quicksand to.....535 feet.

Owing to an accident this well was not completed.

These last two borings were kindly furnished me by Mr. E. R. Hathaway, well contractor, of Montezuma.

These latter wells were sunk into the Lignitic series.

FORT GAINES WELL.

The record of this well is lost, but it reaches a depth of about 650 feet. The lower 350 or 400 feet of these strata belong to the Ripley or Upper Cretaceous system, which is overlaid by the impervious beds of the Lower Eocene limestones. The water rises to within 20 feet of the top of the well.

CUTHBERT WELL.

This well was sunk to a depth of 1,000 feet, but the record was not kept. From a point between 340 and 400 feet water rose within 30 the surface, and at 550 feet the water rose to within 70 feet of the surface. The conditions are similar to those at Fort Gaines. The water comes from the upper portion of the Ripley series, of which the bed between 340 and 400 feet is probably identical with the water-bearing bed at Fort Gaines.

DAWSON WELL.

- | | |
|--|-----------|
| Clayey white sands to..... | 40 feet. |
| Coarse sand to..... | 80 feet. |
| Limestone, followed by sand and rock repeated, to..... | 650 feet. |
| Quicksand to..... | 660 feet. |

Water rose near to surface in the pipe, but does not flow. This well is also in the Ripley series, overlaid by a moderate thickness of the Lower Eocene strata.

AMERICUS WELLS.

One well was sunk to a depth of nearly 1,600 feet without success, but of this there is no record. Another well, at the railway station,

was sunk to a depth of about 500 feet, with a water supply. A new well at the water-works gives the following section :

1. Surface clay.....	3 feet.
2. Blue clay.....	70 feet.
3. White marl and limestone.....	11 feet.
4. Hard limestone.....	6 feet.
5. Blue clay.....	7 feet.
6. Limestone layer.....	$\frac{1}{2}$ foot.
7. White sand.....	5 feet.
8. Rock and clay.....	123 feet.

Whether the water will flow from the wells, or require to be pumped short distances, will be a matter of local determination. For smaller wells this can easily be accomplished by wind-mills as in many other localities. For the occurrence of artesian water it is necessary that the beds should be covered by impervious layers; but where these layers are tapped by great river valleys, then the conditions may be such as to allow the subterranean waters to be discharged without being forced upward through the artesian borings to the surface of the ground.

Whether the Cretaceous country north of the line between Fort Gaines and Montezuma contains a sufficient number of impervious beds of clay to permit of the accumulation of artesian waters or not, cannot be reported upon at present.

Flowing water cannot be expected from a large section of the district in which there may be reasonable expectation of a water supply, as the original source of the water does not come from great elevations to the north.

In the country underlaid by Miocene strata, the water supply must either be looked for in comparatively shallow wells, or at great depths, after penetrating the thick Upper and Middle Eocene and reaching the lower strata.

Whilst throughout much of Southern Georgia, the Upper Cretaceous and the Lower Eocene beds are capable of furnishing water, we may look to the caverns in the limestones of the Eocene formation for the drainage of many unwholesome swamps or ponds. As has been pointed out in this report, many of the lakes are evanescent, owing to the clogging and reopening of the subterranean passages. As some of the Eocene limestones are very cavernous, it is not unreasonable to expect, in the regions of the ponds, caused by sinks, that by boring, outlets could be very often obtained; if not by the subterranean channels in the limestones, then by some porous sandy strata beneath. Such results have been accomplished elsewhere, and this method would simplify the drainage question in much of the flat country where it is most needed.

It may not be unsafe to predict that the time will come when much of Southwest Georgia will be supplied with artesian water, and the malarial ponds, where such occur, be drained. It is to be hoped that the data set forth in this report will call attention to the value of artesian water, and the importance of the preservation of the well-records, which in the hands of a geologist, can be used in extending our knowledge of the water supply. It will simplify the question of the water supply for farms as well as towns. But in this preliminary report, the first that has appeared relating to Southwest Georgia, only an outline can be expected, which sooner or later, can be supplemented, as the difficult work of outlining is now accomplished.

Speaking in a general way, the present surface wells, in Southwest Georgia, pass through the orange loam into the beds of sands, or of sand and clay, which generally underlie the red loam. They vary in depth from twenty feet to one hundred; at which depth they enter the Cretaceous or Tertiary deposits. The deeper wells are generally bored with a diameter of about eight inches. In many cases the well water is excellent. However, in the lower and more imperfectly drained districts, pure water cannot be expected from surface wells; for whilst sand acts as a filter, still, it is too imperfect to remove all unwholesome matter. The artesian water, being protected from the surface drainage, by impervious layers, and coming primarily from distant and more elevated regions, must, of necessity, be more wholesome than ordinary surface wells.

CHAPTER VIII.

PHOSPHATE, LIMESTONE AND MARL DEPOSITS IN SOUTH-WEST GEORGIA.

PHOSPHATES.

Phosphate beds are now being worked three miles westward of Boston, in Thomas county. These beds were the first reported upon by me to the Governor, in September, 1890. Since that time, further developments have been made, and a more extended knowledge of the associated beds, have been acquired. In the first place, the subjacent rocks are fossiliferous Miocene limestones, probably belonging to the middle part of that system. These limestones are highly silicified, in their upper portion, and consist, in places, of scarcely more than a so called flint, in which the same fossils occur as in the adjacent limestone. This so-called flint is more or less translucent, light, and softer than the normal condition. Upon exposure it becomes white; in short, it appears to be a variety of opal, rather than quartz; and some of it contains traces of phosphoric acid, but it was primarily formed from the silicification of limestone. Upon this, and more or less mixed therewith, are the beds of phosphate. The phosphate, in part, appears to have been formed contemporaneously with the flint, owing to the close commingling of some of the deposits.

The phosphate occurs in more or less concretionary masses, which sometimes make up the great mass of the deposit, to a depth of ten or fifteen feet, or more. Again, it is scattered through the clay from which it can be separated. The phosphate may be in a very hard form, or it may occur as a soft white powder; resembling calcareous marl. The appearance of the phosphate is so extremely variable, that it is never safe to pronounce an opinion upon even similar materials from two different localities without careful examination. White is the prevailing color, but it is often tinted, and greenish color is common. Iron and alumina are objectionable mixtures, as these not only reduce the quantity of the phosphate, but also make a less desirable product. When the iron is present in objectionable proportions, it appears in the form of bright stains, or rust. The presence of alumina requires more careful determination. The phosphate, in the pits now being worked, is of high grade, running to 70 per cent. bone phosphate. All the phosphate beds occur in pockets of larger or smaller size, and none can be found in uninterrupted sheets. The character of this phosphate is similar to

that in the interior of Florida; where most commonly, it is derived from phosphatization of limestones, as frequently shown by even the phosphatized shells being well preserved. But in Florida, I have occasionally seen the phosphate deposits intercalated with white sea sand. The beds of phosphates commonly occur on the edges of slight undulations of the country; as the phosphate has the ability of resisting meteoric solution, to a greater extent than the limestone beds. Phosphate beds, west of Boston, have been found in several localities. At the largest pit opened, portions of the phosphate beds are covered with stratified clay, resting in part at an angle of 45 degrees, and internally often showing slickensided surfaces, thus recording the great lateral thrusts since the deposit was found. This disturbed clay is covered with an orange loamy clay, which reaches from 4 to 10 feet in depth, and is succeeded by about 18 inches of superficial washed sand. In an adjacent well, the orange loam is underlaid by red sand and a laminated blue clay, dipping at 30 degrees to the southward. This locality has an elevation of about 160 feet above the sea.

The exact age of the phosphate beds cannot be determined. They are newer than the Middle Miocene limestones upon which they rest, and we find them beneath the disturbed layers of clay, which underlie the Lafayette loam. The importance of these disturbed beds is considerable. They do not occur alone at the phosphate pits, but may be seen in several railway sections between the mines and Boston. These beds, I did not describe in the chapter upon the Miocene; but whether they belong to the Upper Miocene or Pliocene, must be left for future investigation. They form a distinct series or division; and in order to understand them better, the following sections along the railway are given: In the railway cut, just east of the phosphate switch, the surface is covered with a variable thickness of orange loam resting unconformably upon and filling a syncline, or basin, in white and purple clays, whose laminations are separated by red sandy parting. These rest upon a white and blue clay, rising as a dome from beneath the laminated clays. Between the last two divisions, at one point, there is a wedge of reddish clayey sand, at one point, which resembles the superficial red loams. In railway cuts, farther east, several sections were observed, and the following gives a generalized idea:

1. Orange loam passing, in its lower part, into..... 4 to 10 feet.
2. A bluish and reddish clay..... 3 to 20 feet.
3. Hard reddish sandy clay..... 2 to 5 feet.
4. Undulating laminated purple and white clay, with red sandy partings..... 5 feet.
5. White and yellowish mass rises, forming interruptions in the overlying masses..... 5 feet.

In one railway section, the beds, from 2 to 4, form a synclinal basin dipping at considerable angles, filled at one point to a depth of 15 feet with the loam of No. 1. No. 3 is twice repeated, including three bands like No. 2 and No. 4. The disturbances along the strata are considerable, so that No. 4 rests against or upon No. 1. This may be the result of land slides. In one place, No. 1 contains an irregular layer of large fragments of cherty rock. The structure is difficult of explanation, and the resemblance between some of the enlarged sandy partings and the surface loams is so close as not to be distinguishable, except by the stratification. These disturbed strata are probably of the same age as those at the phosphate beds and belong to a period intervening between the Middle Miocene silicified limestones and the overlying Pleistocene loams.

The fossils of the silicified limestone, underlying the phosphate beds, have only in part been studied, and Dr W. H. Dall has provisionally determined, for me, their approximate age as Middle Miocene.

The origin of these phosphate beds is not well understood. They are not derived from an accumulation of marine animal remains, but have been formed by the phosphatization of beds of limestone, whose structure and fossils remain. They have been formed where they now rest. The source of the phosphoric acid was from above, as the deposits diminish in richness in descending. This source was, probably, from the remains of maritime birds, similar to the leached guano beds on the coast of South America and elsewhere. As the organic matter decayed, the more or less soluble phosphoric acid turned the subjacent limestone into phosphate. This explanation will account for the irregular character of the deposit arising from the favored and unfavored resting places of the birds.

In some of the loams, adjacent to these nodular deposits of phosphate, considerable quantities of the mineral are found in the form of pebbles, having been derived by the action of the waves from the phosphatic rocks constituting the shore. Some of the clay is also found to be rich in phosphate, which is finely commingled with it.

The depth to which the phosphates can profitably be worked varies with the volume. The Charleston phosphates have usually a thickness of from 6 to 15 inches, although greater in places. Under these conditions they obtain from 300 to 1,200 tons per acre, which permits the removal of eight or ten feet of earth (according to Dr. Shepherd); usually 500 tons to the acre are necessary to pay expenses. Hence, the superior value of the deposits of Thomas county, which have a much greater thickness, will easily be seen, if they prove of extensive distribution. Moreover, the Thomas county phosphates reach a higher percentage.

There is a marked difference between the phosphates of Georgia and of the interior of Florida, on one hand, and those of South Caro-

lina and of the rivers of Florida on the other. These latter deposits are boulders or pebbles of the harder phosphate, which have been accumulated by waves and currents from the disintegration of phosphatized beds, such as those in the interior of the country.

The search for phosphates is rendered the more difficult, owing to the surface of the country being generally covered with the heavy deposits of loam or other Pleistocene materials; thereby concealing the subjacent deposits. But when limestones occur at the surface, the inexperienced are very apt to mistake every exposure of marly looking rock for phosphate,—the limestone being distinguished by its effervescence with acids; whilst the phosphate is soluble without effervescence. Still, the latter is difficult of recognition, as it is apt to resemble not merely the marl, but various arenaceous deposits, and requires to be determined by one familiar with its properties.

Phosphatic rocks are wide-spread over Thomas and Decatur counties, but the deposits so far found are not generally of extensive proportions except in the one locality described. I have found deposits of phosphates on Mr. Heard's property about six miles east of Thomasville, associated with exposed limestone; and from the loose stones, in the red loam, phosphatized rock was brought to me from several localities. In the southern part of Brooks county, there is a brecciated looking siliceous rock, which weathers into a white mass containing a small quantity of phosphate, but upon analysis it was found to be of little value. This peculiar rock appears to be composed of silica in an opal form, as it is soft and yet comparatively free from aluminous matter.

These southern counties, underlaid by the Miocene rocks, may afford other beds of phosphates, but as yet the country has been only slightly prospected beneath the loam. Still, where such occurs beneath more than 12 to 20 feet of earth, its value would be impaired or rendered doubtful owing to the cost of excavation.

In the upper portion of the Ripley series, along the Chattahoochee, phosphate matter has been noted (page 38), and in Alabama the same occurs above the Midway series, in beds wanting along the Chattahoochee, but which may yet be found to the eastward (page 49).

LIMESTONES AND MARLS.

Limestones for local building purposes, or for lime, may be obtained in many localities where the Tertiary rocks come to the surface. In the future, their use will be more extensive than now. The limestones suitable for construction are confined to the base of the Eocene system (as in the Midway series), and to the Claiborne and White Limestone series, of the Middle and Upper Eocene. Many of the beds are soft, or otherwise unfit for use, but other strata are compact, and harden on exposure. At very few places have quarries been

opened up, and hence their value is imperfectly shown in the weathered and superficial exposures, where the rocks are commonly worn into rough or pitted surfaces.

Closely associated with the surface limestones, in many localities, porous flinty rocks are found in large masses. These have been left upon the wearing away of the calcareous beds, and consequently they are generally found only near the surface or in caverns, as the siliceous matter in the compact rocks hardens the limestone, but does not usually occur as distinct beds. Such chert, when broken, makes excellent material for macadamizing roads. Some of the rocks can be used for millstones. Occasionally, they form beds that could be quarried for a variety of purposes, where a very hard rock is desired.

The softer and incoherent beds constitute marls, which are valuable adjuncts to agriculture, as they supply lime to such soil as is deficient in it, and also some phosphate. Whilst this material is a fertilizer and enhances the general value of the land, yet its effects are not seen immediately, until the plants reduce it into a condition favorable for absorption as plant food, which is eventually done, and the general quality of the land improved.

The distribution of the limestones is co-extensive with the geological formations indicated. The softer and marly beds usually occur in the Lower and Middle Eocene; they also occur in the Miocene formations on one side, and in the Cretaceous on the other. A complete list of localities cannot be given in this general report, as the survey has not had the opportunities of carrying out detailed work. The best exposures of the various rocks seen are adjacent to the rivers or streams, which have left the rocks exposed in the cliffs or in the river channels.

CHAPTER IX.

THE SOILS—BRICK CLAYS.

The soils of Southwest Georgia are directly derived from some portions of the Columbia or of the Lafayette beds; yet they present a considerable diversity, owing to the changing characters of these superficial accumulations, dependent upon the underlying geological formations. Thus, in the counties over the belt of the Tuscaloosa and Eutaw formations, the rolling table-lands are sandy, whilst the deeper valleys partake of the nature of the lower formations, or are occupied by the second bottom, or Columbia deposits, as at Columbus. To the southward, there is a marked difference between the soils over the Ripley series, which are generally heavy red loams, and the more sandy loams overlying the Eocene limestones, or the heavy sands in counties along the Flint river. Again, the rolling lands of Decatur and Thomas counties show an equally marked contrast. These differences arise, in part, from their mode of formation, but largely from their admixture with materials of local origin. The practical information wanted is, to know what they are best fitted for and their deficiencies. Such an investigation is quite out of the question until the survey is provided with a chemist, and until time can be given to the necessary work in the southwestern part of the State, which is absolutely necessary in order to make any agricultural report.

By way of illustrating this variation in the suitability of soils, we may call attention to the culture of Cuban tobacco in Decatur county. Thus, in the region of the Attapulcus, the variety produced is fine, and commands a price by which the yield per acre may amount to \$200 or more. In other localities, with the same climate and similar appearing soils, the tobacco is found to be coarse and will command a much less price. This is attributable to the greater quantity of lime in the soil, which renders the weed more thrifty at the expense of delicacy of the plant, whereby the price is enormously diminished. The demarcation of such zones, of course, could only partially be attempted up to this time. These tobacco lands are coincident with the Miocene formation.

Of the other new industries, the pear culture is rising to prominence in the southern part of the State. In the belt west of Fort Valley, the peach and other fruit growing for early shipment has been

found very lucrative. But the delimitation of a belt of these rolling sandy soils on the higher lands of this portion of the State, freest from frosts, could not be determined in the short period of work. The most favorable melon localities must share the same fate, in this preliminary report. These new industries will not merely diversify our products, but will enhance the wealth of the people, as has been effected in other States, and consequently increase the value of lands. Hence, the importance of carrying this geological survey to the limit of detailed agricultural investigation.

BRICK CLAYS.

The orange loams or the "hill clays," make bricks which assume a very rough surface and dark colored, from the fusion occasioned by the presence of large quantities of iron; hence, the favorite clay resorted to in brick-making, is that derived from ponds, which, however, has to be well-selected. At a few localities, where the Eocene clays come to the surface, such may be used for brick-making. The Columbus bricks, both common and pressed, are extensively used over a considerable portion of the State. This clay comes from the terraced plains of Columbus, and belongs to the Columbia division of the Pleistocene system. At various points, down the Chattahoochee, as far as Fort Gaines, this clay is used, but, from the latter point, the clays contain an excess of lime derived from the subjacent calcareous members of the Tertiary formations. Consequently, in the southern part of the State, the pond clays must be resorted to for brick-making.

CHAPTER X.

THE TIMBERS—THE CLIMATE.

THE TIMBERS.

Along the lower margin of the State, there is an admixture of valuable oaks with the long-leaved yellow pine, but, on approaching the northern boundary of the Miocene deposits, the timbers of the country are almost exclusively pine, except in the vicinity of the rivers, where there are white and red oaks, cypress and gums. This condition occurs throughout the northern part of Decatur and Thomas, Miller, Mitchell and the greater parts of Early, Baker and Dougherty counties; but on the more hilly lands of the Lower Eocene, and of the Cretaceous formation, we find an admixture of pine and of oak. In making the preliminary survey, extensive large pine forests, of valuable timber, were traversed. In localities, nearer the railways, the best trees have been cut off. At many points, the turpentine industry formed a conspicuous feature, but yet not enough to greatly reduce the value of the pine forests.

CLIMATE.

The compilation of such meteorological data as are accessible will not be attempted in this report. In the belt of country included in this report, we find the elevated ridges of Thomas and Decatur not merely desirable for winter residence, but also healthful in summer. The advantages of this belt for winter residences, for invalids and others, have been demonstrated by the success of Thomasville, now resorted to by thousands of tourists. Numerous other places, along this belt are equally favorable, and along the railway, Whigham and Bainbridge are desirable. Bainbridge is on the Flint river. Its artesian water adds to its healthfulness, and it is now rendered one of the most desirable localities for winter hotels. In the pine forest, a few miles from the railway, the picturesque Forest Falls might be made an attractive home. Although situated so far south, I have found that the climate and healthfulness of much of Southwest Georgia is equal to that of the more northern part of the State. No tourists' hotels have been built in the more northern part of this section of the State, but there is no climatic reason why they should not be constructed at many points. A new hotel is in process of construction at Americus which may rival those farther South. On the higher lands of this section of Georgia, under consideration, we find some of the most desirable portions of the State, with an excellent climate.

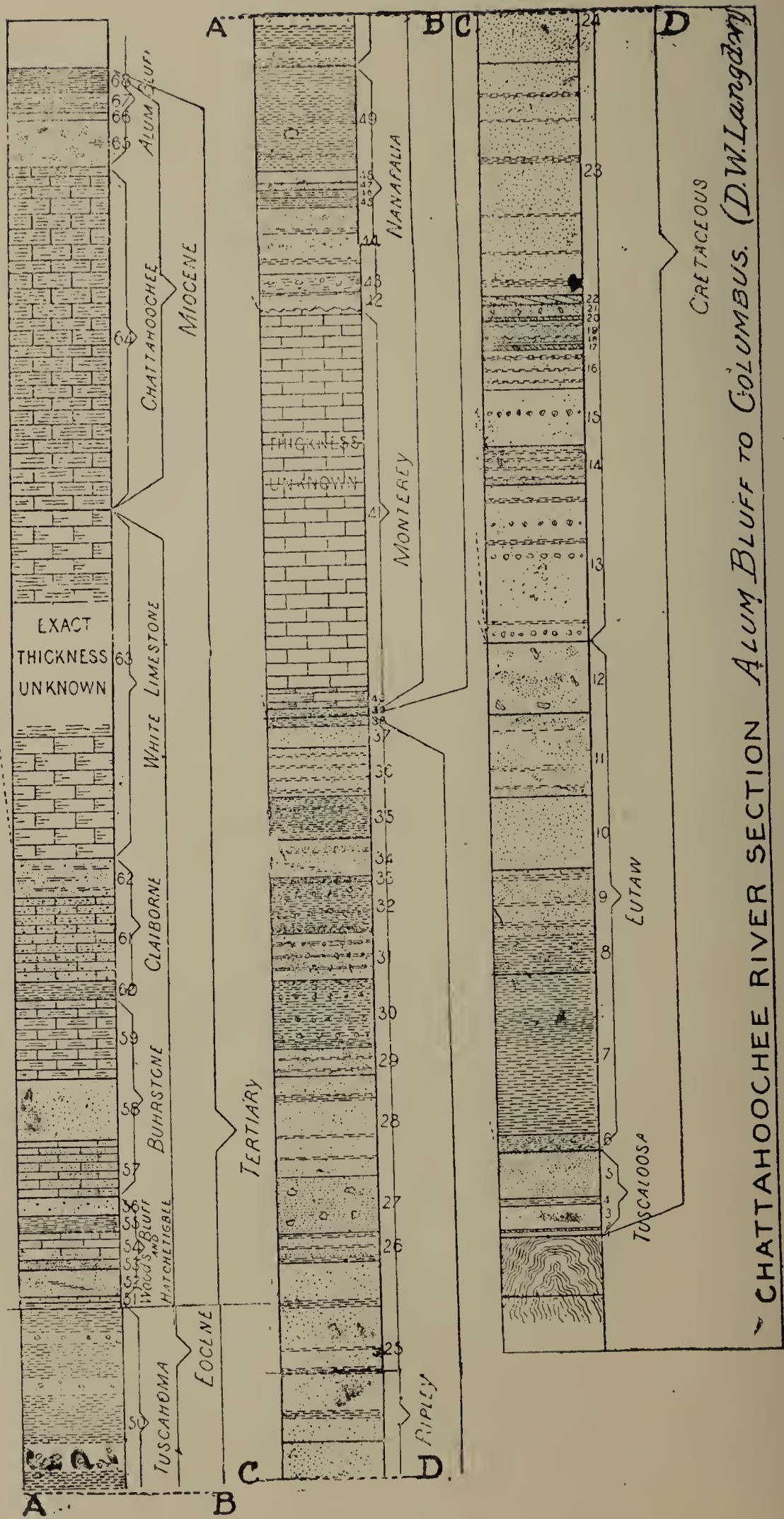


FIGURE 11.

CHAPTER XI.

GEOLOGICAL SECTION ALONG THE CHATTAHOOCHEE RIVER FROM COLUMBUS TO ALUM BLUFF.

By D. W. LANGDON, A. M., F. G. S. A.

[This section equally concerns Georgia and Alabama, and is therefore published by J. W. Spencer, State Geologist of Georgia, with the consent of E. A. Smith, State Geologist of Alabama, and of the author

The joint explorations of the Chattahoochee river were made by the Geological Surveys of Alabama, Georgia and the United States. The use of the following excellent, detailed section aided the progress of that survey and saved duplication of work. Its publication gives minute details as to character of strata.

The following section is down the river, but it is in geologically ascending order.

TUSCALOOSA SERIES.

- 1. Light green, highly micaceous sand, resembles weathered schist, and but for occasional water-worn pebbles, might be mistaken for schist..... 3 feet.
- 2. Hard clay stained by ferruginous matter, breaks with conchoidal fracture..... 1 foot.
- 3. Hard, white coarse-grained sand, held together by white clay 15 feet.
- 4. Red and gray variegated sandy clays (typical Tuscaloosa), shows, at water's edge, mouth of Bull Creek.....

EUTAW SERIES.

- 5. Strongly cross-bedded coarse sand and pebbles with some few fragments of schist, and just enough white clay to hold the mass together. The quartzose pebbles are all well water-worn, while the softer bits of schist are but slightly abraded. This stratum varies in color from white to lemon yellow and in places green, while the upper part becomes purple and yellow variegated. This last phase is most strongly developed at Thomas' Bluff, Georgia, due east of Fort Mitchell..... 40

6. Dark gray calcareous sand, pyritous, and containing nodular masses 6 to 12 inches in diameter, with calcite nuclei. These nodules are arranged in strata about two feet apart, and terminate in an indurated stratum about 12 inches thick. Small fragments of lignite are scattered about through this stratum, and one or two large masses filled with calcitized teredos are found. The only other fossils seen were an *Anomia* and an *Exogyra*,—probably the young of *E. costata* (Say). The fossils are all poorly preserved. Dip at this point 40 feet to the mile southward.. 15 feet.
7. Gray sand of the same nature as the preceding, only no nodules were seen, and the shells increase in quantity, particularly in the lower part. The upper part of this stratum becomes more argillaceous and contains no fossils. Causes landslides in the banks like the Black Bluff clays, which they resemble somewhat physically. These sandy clays give rise to Uchee shoals.....100 feet.
8. Laminated dark gray clays with masses of yellow sand distributed at irregular intervals throughout this stratum, best developed just above the mouth of Uchee Creek, Alabama..... 25 feet.
9. Yellow and white sand with thin seams of lignitic sand, and an occasional "bunch" of gray laminated clay. These sands are exposed in a bluff about 100 yards from the river just below the mouth of Rooney's Mill Creek, Georgia..... 50 feet.
10. Quartzose conglomerate, much like that at Havana, Hale county, Alabama. From the shoal at Beden's Rock, and the bluff at Hatcher's Lower Landing, merges gradually into a yellow sand:..... 50 feet.
11. Yellow sands and gray clay containing bits of leaves. This stratum and the following are seen at Chimney Bluff, Georgia..... 60 feet.
12. Light yellow and white sands containing beds of well rounded quartzose pebbles, sometimes 20 feet thick, Lignitized logs seen protruding from the bluffs. The sands contain a small *Exogyra* at rare intervals. The supposed top of the Eutaw group..... 45 feet.

RIPLEY SERIES.

13. Gray sandy calcareous clay with lines of boulder-like concretions projecting from the bank; first seen at Lawson's wood-yard. Few fossils occur in the lower part of this stratum except *Exogyra costata*. A mile above Bluffton, Georgia, characteristic Ripley shells, mostly bivalves, are

- found in a much decomposed state, throughout the stratum 6 to 8 feet thick. The uppermost ten feet of this stratum, highly fossiliferous. The river washes out little cave-like recesses in the banks. Near Jernigan Landing, Alabama, slight rolls in the strata are seen, involving about 20 feet of the sands ; these miniature anticlinals and synclinals continue to within two miles of Florence; the dip estimated from the line of boulders, averages about 20 feet to the mile, and is normal in direction.....120 feet.
14. Two miles above Florence, and making a part of a bluff 50 feet high at that place, is a gray sand interlaminated with thin seams of a more argillaceous sand, all of which is unfossiliferous. Dip about 40 feet to the mile..... 26 feet.
 15. Gray calcareous sand containing a small *Anomia*, and a line of hard rounded concretionary boulders..... 40 feet.
 16. Gray and yellow sands resembling in physical characters, those of the Tertiary at Lower Peach Tree, Alabama..... 30 feet.
 17. Gray highly fossiliferous marl; the fossils are nearly, if not quite, all bivalves, and are mostly comminuted as if they formed an ancient shore line. There are numerous sharks' teeth, a hard black substance in sections, resembling the under shell of a turtle, black coprolitic (?) pebbles, and fragments of lignite..... 3 feet.
 18. Sandy stratum, indurated, and containing *Ostrea* sp. (?).. 1 foot.
 19. Cross-bedded gray sands and clays..... 15 feet.
 20. Fossiliferous marl about the same in character as 17; only little or no lignite was seen, the marl appearing to be somewhat glauconitic. (The strata from 17 to 21 inclusive, form a bluff on the east side, five miles below Florence)..... 2 feet.
 21. Gray glauconitic calcareous sand, weathering into fucoidal masses, and containing a few soft white phosphate nodules..... 10 feet.
 22. Gray fossiliferous marl, shells much decomposed. An occasional lignitized log, and numerous slightly phosphatic nodular masses, containing fossils, occur in this stratum.. 3 feet.
 23. About the same in general character as 21, but contains indurated ledges about one foot thick, which show the dip to average about one foot to the mile, with numerous rolls; ends just above mouth of Cowikee creek... 170 feet.
 24. Soft, less coherent sand, gray in color, appears at the mouth of Cowikee creek, where the south bank of this creek, composed of this strata, may be seen to rise 50 feet from the water..... 60 feet.

25. Gray calcareous sand with indurated edges, *Exogyra costata*, *Gryphæa mutabilis*, *Hamulus onyx*, *Plicatula urtica*, *Anomia* (?), forms the shoal at Frances' bar and Bluff at Eufaula..... 190 feet.
26. Light gray and yellow sands, interlaminated with sand darker in color, more argillaceous and containing bits of lignitized leaves and twigs; no other fossils seen; crops out in the gullies of Eufaula next below the drift..... 20 feet.
27. A massive gray sand with a few fragile fossils and boulders. This sand is only slightly calcareous, and is more or less lignitic. Dip here about 150 feet to the mile... 40 feet.
28. A more calcareous sand filled with *Exogyra costata*, and many indurated ledges, giving rise to the first bar below Eufaula..... 70 feet.
29. Light yellow cross-bedded sands between indurated ledges..... 20 feet.
30. Calcareous *Exogyra* sands with boulders..... 50 feet.
31. Yellow sands and indurated ledges filled with casts, *Exogyra costata*, and echinoderms set fast in the ledge. The sands are cross-bedded and contain some lignitic streaks..... 35 feet.
32. Gray fossiliferous sands with boulders; the sand is massive and is fossil-bearing only in the lowest five feet... 40 feet.
33. Brown, laminated argillaceous sand; disappears at the mouth of Pataula creek, Georgia..... 5 feet.
34. Light yellow sand and interstratified very irregularly with a gray micaceous sand filled with friable Ripley fossils. Mouth of Pataula creek..... 30 feet.
35. Hard sandy ledge, weathered surface jagged, contains *Exogyra costata* and echinoids; very light yellow in color, white when dry and unweathered..... 30 feet.
36. Gray sand with indurated ledges; no fossils seen; merges gradually in the upper part into a dark, almost black sand containing large nodular masses, and interstratified with light yellow sands..... 35 feet.
37. White coarse conglomerate, the matrix material being calcareous. The quartzose pebbles decrease in size towards the top and the stratum becomes more argillaceous; there are many casts, but all too obscure for identification. 18 feet.
38. Massive blue clay; contains a few bits of teredo-eaten lignite (probably the top of the Cretaceous)..... 6 feet.

MIDWAY OR CLAYTON SERIES.

39. Massive sandstone, coarse grained and almost a conglomerate..... 8 feet.
40. Light yellow siliceous limestone, containing a large *Ostrea* and numerous obscure casts. Five miles above Fort Gaines, Georgia..... 10 feet.
41. White calcareous sand, containing a few obscure casts and *Ostreas*. The sand sometimes becomes irregularly indurated, and is the source of small lime springs. Forms the lowest part of the bluff at Fort Gaines, Georgia, and in its uppermost ten feet contains pockets of white sand enclosed by black clay, the clay resting in "pot-holes" in the limestone. Estimated at 200 feet.

NANAFALIA SERIES.

42. Glauconitic sand filled with *Gryphaea thirsæ*, *Ven. planicosta* and *Crassatella*..... 6 to 12 feet.
43. Gray calcareous sandy clay containing boulders of clay and a few decomposed *Gr. thirsæ*..... 15 feet.
44. White and lignitic and cross-bedded sands, and sandy gray clay, containing one or two ledges of pseudo-buhrstone..... 50 feet.
45. Dark gray argillaceous sand, with new fossils and fragments of water-worn clay balls. The lower part becomes more fossiliferous, containing *Osteodes caulifera*, *Ven. planicosta* and *Gr. thirsæ*..... 6 feet.
46. Greenish gray, fine grained calcareous sand, very firm and holding decomposed shells, mainly bivalves..... 6 feet.
47. Coarse glauconitic sand, filled with large *Ostrea compressirostra*, *Ven. planicosta*, and a small *Pecten* resembling the species occurring at Yellow Bluff on the Alabama river..... 3 feet.
48. Cross-bedded sands, yellow; the bedding planes being marked by streaks of gray clay..... 10 feet.
49. Yellow and gray sandy clays, containing occasional beds of *O. compressirostra* and *Gr. thirsæ*. The indurated ledges which sometimes occur, seldom over two feet thick, are of the nature of pseudo-buhrstones, and are filled with bivalves; the only exception being *T. mortoni* (large). This disappears below the surface at the mouth of the first large creek flowing from the Georgia side, below Fort Gaines..... 75 feet.

TUSCAHOMA (OR BELL'S LANDING) SERIES.

50. Light yellow and gray sandy clays, containing, in the sandier portion, boulders much like those seen at Bell's Landing. No fossils seen. These are undoubtedly the lower Peach Tree clays and sands. They become more sandy on ascending..... 170 feet.
51. Light greenish yellow sands, filled with bits of decomposed shell and large *O. compressirostra* and *Ven. planicosta*..... 3 feet.

An interval of fifty yards and then,

BASHI (OR WOOD'S BLUFF) SERIES.

52. Gray sand filled with decomposed fossils. An irregular indurated ledge (non-fossiliferous) occurs in this stratum. This is probably Bashi, though the only fossil that could be determined with any degree of accuracy, is the small oyster so common at the typical locality..... 18 feet.
53. Blue clay, slightly sandy..... 6 feet.
54. Light yellow siliceous (sandy) limestone, filled with casts and containing pockets of *O. compressirostra*..... 18 feet.

HATCHETIGBEE SERIES.

55. Gray lignitic sandy clay (Hatchetigbee)..... 10 feet.

BUHRSTONE SERIES.

56. Coarse white sand, containing *O. divaricata*, and a few other friable shells in the upper part..... 12 feet.
57. Buhrstone, the first flexures since leaving Eufaula occur in the stratum. Rather sandy..... 40 feet.
58. Light yellowish green sand, containing numbers of small *O. sellæformis*..... 45 feet.
59. Buhrstone..... 55 feet.
60. Greenish yellow calcareous clay, with a few decomposed fossils, and an occasional large *O. sellæformis*..... 12 feet.

CLAIBORNE SERIES.

61. White sandy limestone with small *O. sellæformis* in abundance, and pockets of larger sized shells. Makes capping ledge to island at mouth of Omussee creek, where the bluff is about twenty feet high. This stratum is made up of alternate beds of hard and soft strata; all containing more or less of *O. sellæformis*. The harder strata weather out into root-like shapes, and are sometimes rather argillaceous. Many return dips occur in this stratum, stringing it along the banks for many miles further than it would be normally.

The dips are all steep both ways, and many gaps in the succession are caused by the washing out of the softer beds. Owing to these gaps and return dips it is rather hard to estimate the thickness of the stratum with much accuracy. It dips below the surface of the river, two miles below Gordon, Alabama, and is last seen on the Georgia bank. At Gordon there is a very pronounced return dip, estimated at, and not exceeding..... 60 feet.

WHITE LIMESTONE SERIES.

62. The *Scutella* bed, from the beginning, weathers so as to make it not possible to count up its thickness. It is literally full of fossils; mainly *Scutella Lyelli* and *Pecten nuperus*, with a few smaller and thicker Scutellæ. A bluff about twenty feet high occurs opposite the mouth of Sowhatchee creek, Ga.....25 to 30 feet.
63. White orbitoidal limestone, seen first at Dougherty's Wood Yard, Georgia, and on the Alabama side, nine miles by river from Neal's Landing. This limestone contains numbers of echinoids about five miles above Neal's. The limestone continues as far as Miriam's Landing, at which place the thickness is..... 200 feet.

CHATTAHOOCHEE SERIES.

64. Argillaceous and sandy limestone, alternating with strata of purer character. Contains a *Pecten* and an *Ostræa* very close to our recent *Virginica*. This may be termed the Chattahoochee group, as it is well developed there and along the eastern river bank, for the next ten miles..... 25 feet.

ALUM BLUFF SERIES.

65. Light yellow sand, containing pockets of fossils. Where there are no shells, the sand is very calcareous. Fossils resemble those described by Conrad, as Miocene from York county Virginia, and Maryland.. 35 feet.
66. Gray sand, slightly calcareous..... 5 feet.
67. Gray calcareous sand filled with shells. The leading fossil is a *Macra*.....10 to 15 feet.
68. Black lignitic sand. This contains much pyrites, and from the efflorescence of ferrous sulphate arises the name Alum Bluff. Varies with the preceding...10 to 15 feet.

CHAPTER XII.

GEOLOGICAL SYSTEMS IN POLK COUNTY.

INTRODUCTION.

[NOTE.—A GEOLOGICAL MAP OF POLK COUNTY HAS BEEN PREPARED. FACILITIES FOR ITS PUBLICATION ALONG WITH THE PRESENT REPORT HAVE NOT OBTAINED.]

Extending across the northwestern part of the State, there is a large belt of country occupied by stratified rocks, although disturbed and in places metamorphosed, belonging to the Palæozoic group. This area forms a natural division for geological exploration. Polk county was chosen as the district for commencing the survey of this division, as it is situated upon the border of the State, and is traversed by the boundary line between the Palæozoic formations and the metamorphic rocks.

From the economical standpoint, this county is of no less importance than from the scientific, for in it there are vast deposits of brown iron ore, limestone, slate, etc., as well as rich agricultural lands.

But the relationship of these useful minerals, to the rock systems of the country, can only be made intelligible after a consideration of the characteristics and distribution of the geological formations occupying the county.

The geological formations of Polk county are all disturbed and thrown out of their original positions, thus producing many complications. The rock materials are generally decayed, so as to leave upon their surfaces only skeletons of their primitive conditions. Under such circumstances, it is necessary to draw more or less of our information from beyond the boundary of the county, in order to ascertain the geological relationship of the formations which are found therein. Without waiting for the time when the detailed knowledge of the geological structure of the Palæozoic formations of Northwest Georgia shall be ready for publication, it is necessary to anticipate and briefly present the position which Polk county holds in relation to the rock systems of the country.

The great geological groups are, in descending order:

<i>Groups.</i>	<i>Systems.</i>
CENOZOIC.	Modern. Pleistocene. Pliocene. Miocene. Eocene.
MESOZOIC.	Cretaceous. Jurassic. Triassic.
PALÆOZOIC.	Permian. Carboniferous. Devonian. Silurian. { Cambro-Silurian or Ordivician. Cambrian.
ARCHÆAN.

The southern margin of Polk county is occupied by semi-metamorphic rocks of uncertain age. All the other formations of the county belong to the Palæozoic group, and almost entirely to the Cambro-Silurian system, with a limited area assigned to the Cambrian, and smaller developments to the base of the Devonian and Sub-Carboniferous systems.

The subdivisions of these systems, which occur in Polk county, can be better understood from the following table, in descending order :

<i>Systems.</i>	<i>Series.</i>
CARBONIFEROUS.	Lower or Sub-Carboniferous (Ft. Payne Chert, Hayes.)
DEVONIAN.	Oriskany?
SILURIAN.	Wanting.
CAMBRO-SILURIAN OR ORDIVICIAN.	Nashville Slates and Maclurea limestone (Safford), or the Chickamauga limestones and Rockmart Slates. (Hayes.) Knox Dolomite. (Safford.)

CAMBRIAN.

Knox Shales (Safford), or Con-
nasauga Shales. (Hayes.)Knox Sandstone and Chilhowee
sandstone (Safford), or Rome
sandstone and Weisner
quartzite. (Hayes.)

ARCHÆAN.

Doubtful.

The scientific consideration of these formations must be postponed until all the observations bearing upon them in Northwest Georgia shall have been made; consequently only their modes of occurrence in Polk county, compared with the typical localities, will be considered in their proper places.

CHAPTER XIII.

THE PHYSICAL FEATURES OF POLK COUNTY.

The topography of Polk county presents a variety of features, from bold mountains to rolling plains or valley lands. The general altitude of the country varies between 850 and 1,000 feet above the sea, with only limited ridges rising higher, except along parts of Dug Down Mountain, near the southern margin of the county, which rises to between 1,200 and 1,400 feet. This range of high lands forms a characteristic feature, extending in a line, convex towards the south, across the southern part of the county, from south of Esom Hill, near the Alabama boundary, to the eastern border of the county, southeast of Rockmart. The name, however, was originally applied to the central portion of the range, near the Dug Down Gap.

The boldest feature is upon the western border of the county, where Indian Mountain is situated on both sides of the State line. It rises to an elevation of 1,800 feet in Georgia, and reaches its maximum height of 1,982 feet, about a mile beyond the State line. Hence, it forms a feature rising a thousand feet above the valley to the eastward. From the foot of Indian Mountain, there is a chain of valleys extending north-northeastward to Floyd county, bounded on the east side by ridges rising two or three hundred feet above it. In the central portion of the county, the undulations are broader with the ridges subordinate to the general features. The eastern part of the county becomes characterized by more pronounced ridges. Most of the valleys which traverse the county can scarcely be considered as due to the erosive action of the rivers, for these flow through broad plains in shallow courses, which have not cut channels for themselves deeper than the required wants of the modern streams. In short, the streams are all flowing at the surface and without alluvial plains; yet the country, between the ridges or rolling highlands, is often broad. The valleys between the ridges also show their independence of the existing streams. Still, everywhere, there are the marks of great antiquity stamped upon the physical features of Polk county in spite of the youthful appearance of the water courses, for all the rocky prominences are generally removed from the higher lands, which are weathered into rounded outlines. The principal exceptions to this statement are found in the bold quartzitic cliffs of Indian Mountain, and in the limestone and slaty ridges in the Rock-

mart district. The slaty rocks also appear along the slopes of Dug Down Mountain, but the features are not so bold in as the other localities named.

Many of the ancient valleys have, to a greater or less extent, resulted from the mountain movements, which have brought the ridges into prominence. But all of these outlines have been greatly softened down by atmospheric agents, and the base line of river erosion appears to have been reached in ancient times. The subsequent changes of elevation, in this region, has not disturbed the equilibrium so as to allow the rivers to cut down their beds into deeper channels.

As the small streams emerge from the Dug Down Mountain range and Indian Mountain, there is an exception to the last statement in regard to the deepening of the channels. These streams are excavating insignificant *canons* and flow over rapids or successions of low falls. But, in such positions, all the streams are small, being near their sources, with water, generally free from mechanical sediments, flowing over the durable although slaty and schistose rocks.

No large streams cut across any of the greater ranges or ridges in Polk county. The county itself forms an amphitheatre, or basin, closed in on three sides, with numerous streams rising upon their borders and flowing northward. These water veins gather up the drainage into three arteries: Cedar creek, flowing through the western portion of the county to join the Coosa river; the branches of Fish creek, in the central portion; and those of Camp creek, farther eastward, uniting to form the head-waters of Euharlee creek, which carries off the drainage of the eastern area to the Etowah river.

The variable, stony and clayey surfaces of the ridges, the slaty or loamy character of the lower lands, and the limestones along the streams, form features of topographic variation and importance, all of which are dependent upon the geological structure and are of particular importance, both from agricultural and mining standpoints; hence, their consideration will be delayed for later pages of this report.

CHAPTER XIV.

GEOLOGICAL STRUCTURE OF POLK COUNTY.

THE METAMORPHIC ROCKS.

From the southwestward, a zone of certain metamorphic rocks, extends into the county, for a width of only a few hundred yards, near Dug Down Gap; but it increases both westward and eastward to a breadth of three or four miles. These rocks are sharply defined upon their northern side: (a) they form a mountain rising two or three hundred feet in height and facing the lower lands to the north; (b) the rocks of this range are faulted or displaced, being brought to the surface and overthrust upon the rocks north of the great line of fault, which forms its northern boundary; and (c) the character of the rocks is distinct, being composed of hydromica schists of variable texture, but the pearly hydromica appears in more or less shining scales, whether of silvery gray or greenish color.

The fault structure is illustrated in the diagram, 'in which the letter N represents the metamorphic range and P the formations resting against and upon the northern side.'

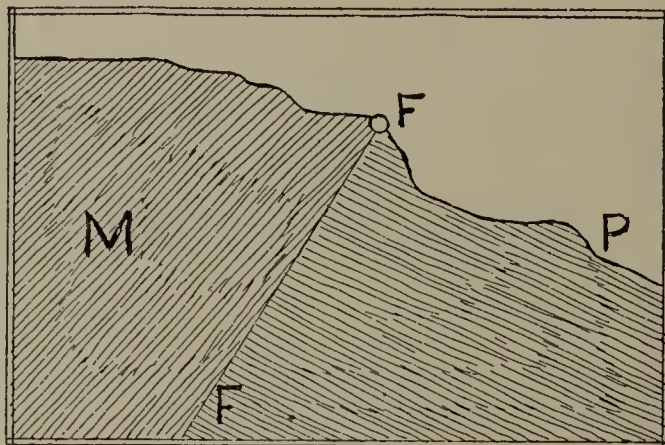


FIGURE 12.

At various points, along the Dug Down Mountain range, the rocks are found to dip at different angles. Near Hightower Mill, the dip is nearly forty degrees in direction S 80° E. Farther eastward, at Simpson's Mills, the dip is lessened to 20° or 25°, and in direction between S 30° and S 50° E. A few miles westward, at Brown's Gap, the rocks also dip at comparatively low angles toward the south. In several places, north of the fault line, the rock formations were

observed to dip at angles much greater than those of the metamorphic range, as near Simpson's Mills.

The hydromica schists are composed of admixtures of the minerals of the hydromica group and grains of quartz. The hydromicas vary greatly in composition, but they are essentially hydrous alkaline silicates of aluminium. They are characterized by their greasy feel and pearly lustre, and are apt to occur in laminae cleaving into mica-like scales.

These hydromica schists are often compact and in thick layers, but easily cleave into rough slabs, or occasionally into smooth slaty-like plates. Sometimes the quartz predominates, in which case the rock is harder than usual. Quartz veins often traverse the rocks, and are frequently parallel to the bedding. Although, everywhere in the county, these rocks are more or less chemically decayed yet they resist degradation and are not readily removed by meteoric agents. The broken schists are usually covered with only thin layers of soil, upon which angular quartz gravel and blocks, derived from the more quartzose layers of the disintegrated schists are often scattered. These hydromica schists form extensive deposits in the State, and their general character and position are subjects of greater consideration than is due their narrow developments in Polk county. They are only semi-metamorphic, and are less highly altered than the mica schists and other rocks farther southward. The information derived from Polk county does not settle their age. Whilst they are younger than the typical Archæan rocks of Georgia, they cannot be placed as the upper members of that group, for it is quite possible that they belong to some portion of the Palæozoic system. Yet they constitute a distinctive feature in the geology of the county, having been overthrust and brought into contact with the various Palæozoic formations immediately north of the fault line, which sharply defines their northern boundary. This fault line was an oblique thrust, which has been traced across Georgia into Tennessee, by Mr. C. Willard Hayes, of the United States Geological Survey,* and which he estimates, to have reached the enormous throw of eleven miles, in one locality—that is to say, there has been a lateral slipping or narrowing of the earth's crust to the extent of eleven miles, where the strata of one zone have been piled on top of those of the adjacent country. Such distortions have added greatly to the difficulties of the geological problems.

As already pointed out, these metamorphic rocks have given rise to a low mountain range, and to the light slaty lands covered with thin soils.

* "The Overthrust Faults in the Southern Appalachians." Bull. Geol. Soc. Am., Vol. II., p. 141, 1890.

CHAPTER XV.

THE CAMBRIAN SYSTEM.

In the northwestern portion of the county, the East Tennessee, Virginia and Georgia Railway passes through a succession of valleys, which mark the boundary between the Cambrian formations and those of the Ordovician system. From the State line, near Etna, for a distance of five or six miles, the narrow valley sharply defines the clayey ridges of the Knox Dolomite formations, on the east, from the slaty Cambrian ridges, on the west. A considerable portion of the valley is underlaid by slate, which rises up into low ridges, covered with a thin capping of soil. Near the surface, the slate is of a drab color, but at greater depths it becomes darker. In texture, it is fine grained and cleaves into thin plates. The dip is at angles of about 20° and in direction S. 40° E. West of these lower slate ridges, others rise, to be succeeded by the *massif* of Indian Mountain, which reaches an elevation of 1,100 feet above the valley. The lower ridges of the mountain are composed of hard slates, with occasional beds of quartzitic sandstone, often several feet thick. The upper portion of the mountain is composed of light, but occasionally dark, colored beds of compact quartzitic sandstone, sometimes approaching the structure of conglomerate. These beds are very thick and form bold cliffs. The strata dip at angles from 40° to 50° towards S. 30° to E. The northern end of the mountain is abruptly cut off and succeeded by strata belonging to the next formation, which thus appears out of its natural position.

A characteristic feature of the Knox shales is the occurrence of intercalated beds of dark blue limestone, which is often oolitic. If these beds are not found in Polk county, they may be seen just north of it.

In these deposits, just described, there are the representatives of three of the divisions of Prof. Safford's classification in Tennessee, namely: the Chilhowee sandstone, forming the *massif* of Indian Mountain, overlaid upon its flanks and lower ridges by the Knox sandstone formations (shales and bedded sandstones), and finally by the Knox shales, occupying the eastern ridges and passing down so as to make the valley at Etna, Pryor, etc. Beyond the limits of Georgia, the Chilhowee sandstones are noted for making bold isolated mountain knobs.

The thickness of these Cambrian formations is very great. Prof. Safford estimated the Chilhowee sandstone formation, in Tennessee, at not less than 2,000 feet, the Knox sandstones at 800 or 1,000 feet, and the shales at from 1,500 to 2,000 feet. Mr. Hayes' estimate of these deposits differs only in making a greater variation of thickness of the first two formations, which together he places at from 2,000 to 3,500 feet, and gives the same estimate for the shales as Prof. Safford. The maximum thickness, here given, is probably too low ; judging from the formations of the Indian Mountain group.

As before stated, the formations of Indian Mountain are abruptly cut off by a transverse fault. But spurs of Cambrian rocks extend southward from Cave Spring, and enter Polk county upon the eastern side of an embayment of the Knox Dolomite series, as will show on the map when published.

In these thick deposits of mechanical sediments, no fossils have so far been found in Georgia. But supposed worm burrows (*Scolithus*), and forms of sea-weeds occur upon the surfaces of some of the beds in Tennessee.

CHAPTER XVI.

THE CAMBRO-SILURIAN OR ORDIVICIAN SYSTEM.

KNOX DOLOMITE SERIES.

This formation occupies by far the greater portion of Polk county: except the limited Cambrian mass which obtains in the northwestern part; an area southwest of Cedartown, covered with younger deposits; another along the headwaters of Fish creek; and a third district in the part of the county, north, east and south of Rockmart, where younger formations overlie the Knox Dolomite.

Where exposed in an undecayed condition, the formation is found to be composed of dolomite or magnesian limestone, and some beds of ordinary limestone. In the middle and upper portion of the series, chert abounds, and occasionally it is found in quantities sufficient to form beds of flinty sandstone. It is from the chert of the upper beds of the Knox Dolomite that the flinty gravel, which covers many of the ridges, is derived. Where preserved, rocks have been found to contain a sufficient number of fossils to identify their position in the geological scale. Stratigraphically, they are found to overlie the shales of the last system.

From investigation of these rocks in Polk county alone, the character of the Knox Dolomite series could not be determined; for they are decayed to great depths wherever examined, thus destroying their lithological structure and organic remains. But the distribution can be determined from the position of their skeleton remains, and the strata of contiguous formations. The observer rarely sees the pure limestone and dolomitic beds, except when brought to the surface from deep wells. Ordinarily, the only rocky masses exposed are beds of cherty sandstone (sometimes ferruginous). But many of the ridges are covered with flinty gravel derived from the smaller fragments arising from the decay of the limestones and dolomites, which have everywhere had their calcareous matter dissolved and washed out by rain waters and springs, thus leaving only such clay and sand impurities as existed in the original rock, and the concretionary cherty masses contained therein. Thus, we find the county covered with residual clays derived from the decay of the calcareous rocks. These residual clays, however, present striking variations. From the more calcareous and less siliceous

limestone, the red clays of the valleys, and some of the hills, were formed. From the more siliceous deposits, especially of the upper portions of the Knox series, the light, sandy clays, commonly covered with loose, superficial, flinty gravel, have been derived. Again throughout the mass, there are irregular pockets of white and purple clays, which are best exposed in the ore diggings or banks.

Wherever the bedding is preserved, we find that the strata have been much disturbed from their original positions, and dip at various angles; thus, fragmentary deposit at one of the Etna mines shows a considerable dip to the northeast. In the railway cut, at Oredell, the dip, at variable angles, has a general direction of north 15° west. But the formation more commonly dips to the southeast. In the country occupied by the Knox Dolomite cherty ridges and valleys, the topographic differences vary with the disturbances of the beds, and the presence of the original pure limestones or more cherty upper beds. Thus the topography appears more rugged in the north-western part of the county than in the southern and central portions. The gray residuary clays abound in the northern part of the county, whilst in the southern portion, there is a great amount of red clay.

The Knox Dolomite series abuts against the metamorphic rocks of Dug Down Mountain in several places.

Numerous wells, to 60 or 90 feet in depth, are excavated out of residual clays of this formation, and an artesian well sunk at Oredell indicates decayed conditions to a depth of 180 feet.

The Knox formation passes beneath the limestones of the next horizon, exposed along the upper branches of Cedar and Fish creeks, and also along of Camp creek, of the Rockmart district. This formation is the great brown ore horizon to be noted later.

From the decayed character of the surface, and from the absence of sufficient rock exposures, it is impossible to estimate the thickness in Polk county, except that it must be very great, as there is a broad extent of country occupied by these formations, which dip at considerable angles; but we do not know to what extent this inclination is reduced by undulations of the strata. In Tennessee, Prof. Safford places the thickness at 4,000 feet, and it appears to be equally thick in Georgia.

CHAPTER XVII.

MACLUREA LIMESTONE SERIES.

In the vicinity of Cedartown, and southwestward; along the upper waters of Fish creek; and in the Rockmart district, the Knox formation is overlaid by massive blue limestones, in color varying from light gray to dark, with a semi-crystalline texture, and slightly metamorphosed. The rocks are best exposed along the streams which flow over them, and in the vicinity of which they frequently outcrop in the valleys. It is only in the eastern part of the county, at Rockmart and beyond, that the rocks rise in bold ridg-lets. The undulating strata frequently lie at low angles, although sometimes dipping steeply, and showing occasional anticlinicals. Thus, at the springs in Cedartown, they dip at 5° to 10° , in direction N. 20° W., but on the south side of the town, there is an anticlinial, at the bridge over Tanyard branch. The dip of the beds on the eastern side is 10° or less, in direction N. 70° or 80° E., whilst on the western side, the dip decreases from 45° to 15° , in direction N. 80° W. However, the beds generally lie at low angles. In the eastern part of the county, they commonly dip at angles of about 20° towards S. 40° - 50° E.

These limestones are generally valley making. In their decay, the weathering is upon the surface and does not penetrate the mass, and hence we do not find the limestone in a decomposing condition, but sharply defined from the overlying residual clays, left after the solution of the calcareous matter. These clays frequently form fertile valley lands.

When these limestones form ridges they are frequently traversed by caverns.

The rock is of the pure limestone type. That at Cedartown yielded the following analysis to Mr. W. J. Land (for the Cherokee Iron Company in 1878):

Calcium carbonate.....	94.37 per cent.
Magnesium carbonate.....	2.10 per cent.
Alumina.....	2.23 per cent.
Undetermined..	1.30 per cent.

The limestone from the great quarry at Devitte, five miles northeast

of Rockmart, gave the following analysis in 1884 (Cherokee Iron Company) :

Calcium Carbonate.....	95.203 per cent.
Magnesium carbonate.....	2.171 per cent.
Alumina and iron.....	0.400 per cent.
Insoluble matter.....	2.300 per cent.

The limestones usually occur in beds many feet in thickness, of compact texture with rarely jointed structure. Indeed, the rocks are slightly crystalline and pass beneath the semimetamorphic Rockmart slates. No fossils have been found in these limestones, whose original structure has been rendered crystalline; but their position has been recognized as identical with the Maclurea horizon of Tennessee.

The thickness of the limestones in Polk county reaches several hundred feet, but the data for the exact determination has not been obtained. The thickness is probably equal to that in Tennessee, which Safford has estimated at 600 feet.

From the fossils found by Professor Safford, the geological horizon of the Maclurea limestones has been correlated with the lower portion of the Trenton division of the Cambro-Silurian system.

IRON-LIMESTONE SUB SERIES (SAFFORD.)

Northeast of Rockmart, and extending for about seven miles, there is a chain of isolated exposures of thin bedded ferruginous limestones, lying unconformably upon the Maclurea limestones, and near the geographical margin of the succeeding Rockmart slates. The rocks are so decayed as to leave scarcely more than laminations of yellow and brown iron ore or ochre. These beds are well shown at the ore pits of the Central Mining Company, about four miles northeast at Rockmart, and at Deaton Mine, a few miles beyond. At the former locality, the ferruginous beds are twenty feet or more in thickness without exposing their full depth. They rest upon a small anticlinal of Maclurea limestone, which trends northeast and southwestward. The iron limestones dip at angles of ten to twenty-five degrees. The individual beds vary in thickness from two to ten inches. Some of the upper beds, as well as certain intercalations, now consist of ferruginated residuary clays, as all the calcareous matter has been removed. These form ochres.

At Deaton Mine, these ferruginous beds rest upon Maclurea limestones, which have been rendered cavernous, in places, beneath a roof of the iron limestone series. This weak roof has subsequently collapsed and filled the chambers with a heterogeneous mass of ore.

The iron bearing series has a thickness perhaps reaching one to two hundred feet. The formation probably passes beneath the slate beds to the southeast. These ore beds will be referred to again.

CHAPTER XVIII.

NASHVILLE (OR ROCKMART) SLATE.

The greater portion of the basins of the Maclurea limestone, in Polk county, are overlaid by the slates of this series, whose areas are fringed by the earlier limestones. Accordingly, there are three basins of these rocks in the county—Cedar creek, Fish creek and Rockmart districts, the eastern having the most rugged and boldest features.

The slates appear to occupy synclinal troughs or folds, and also appear to be somewhat faulted, as they occupy basins upon the limestones, yet are generally seen to dip at considerable angles towards the southeast. Near their junction with a metamorphic belt of Dug Down Mountain, the slates are at very high angles, whilst near Devitte, unconformably overlying the limestones, they dip at only twenty-five degrees. In some of the ridges—as at the slate quarries of Rockmart, in a ridge rising over one hundred feet above the valley, the beds dip at 45 degrees and more towards the southeast, and are obliquely jointed.

Beyond Rockmart, the slate beds appear to be considerably dislocated, thus allowing the older formations to come to the surface, and constituting the broken but more picturesque topography of the county. The shales or slates present a yellowish gray weathered surface, but have a bluer color where less exposed. In some places, in the Rockmart districts, these weathered shales are of a yellow-brown color. Some of the lower beds are composed of fine dark and black slates. In places, these rocks are intercalated with a metamorphic compact conglomerate, containing slaty fragments; such is seen on the road between Rockmart and Simpson's Mills. In Polk county, the rocks all appear to be metamorphic or semi-metamorphic, with the obliteration of such fossils as have been found elsewhere in the formation.

The thickness of the formation in Polk county equals that of Tennessee, or 2,000 feet or more.

CHAPTER XIX.

DEVONIAN AND CARBONIFEROUS SYSTEMS.

ORISKANY (?) SERIES.

A small outlying patch of quartzite succeeds the Nashville slates, about four miles southeast of Esom Hill, near the fault line, at the foot of Dug Down Mountain. These rocks are provisionally classified as Oriskany.

LOWER OR SUB-CARBONIFEROUS SERIES.

The Fort Payne series of chert, of Mr. Hayes, succeeds the slate beds on several ridges southwest of Cedartown. These ridges are covered with cherty blocks and fragments with which iron ores are often associated. On the northwestern side of the most southern ridge (Mr. West's farm), the chert form sandstone beds, which are ferruginous in part. These iron ores will be noticed later.

MODERN DEPOSITS.

Except the continued action of the weathering of the older rocks the creeping down the hillsides of decomposed material, and the occasional deposits, in swampy ground (which is rare); no modern formations can be considered as occurring in the county, for the rivers are not flowing through such lands as would permit of bottom formations. Still there are a few places where the streams overflow basins through which they pass.

CHAPTER XX.

MINERAL RESOURCES OF POLK COUNTY.

IRON ORES.

The aggregate amount of iron ore in Polk county is very large, of excellent quality, and with favorable conditions for mining operations. There are four principal districts, where the ore is now obtained: namely, the East Tennessee Railway district, in the western part of the county; the Cedartown and Camp creek districts, in the central part; and the Rockmart district, in the eastern. But within this geographical distribution, and in other localities, the ore occurs under very different conditions.

KINDS OF ORE.

All the important iron deposits of Polk county belong to the brown ore and limonite varieties.

Pure limonite consists of two varieties. The one is massive, having a globular or botryoidal form, with an interior fibrous structure. The other kind is earthy and massive. The color of the first variety is often rich brown and dark, with frequently a metallic lustre. The color of the latter kind is ochre or brownish yellow with an earthy appearance. The color of the powder in both cases is dull yellow, or yellowish brown. The first variety is hard (5-5.5), whilst the latter is soft. The specific gravity varies from 3.5 to 4. In composition, it is a hydrous sesquioxide of iron, containing when pure: iron, 59.92; oxygen, 15.68; water, 14.40. The percentage of iron falls short, owing to impurities commonly mixed with the mineral. But on the other hand, limonite is apt to lose water, and to graduate into an admixture of itself and hematite, which latter may contain 70 per cent. of the metal. Such is the condition of most of the brown ore of Polk county, often containing not more than two or three per cent. of water. The brown ore always contains some admixture of clay and sand. The percentage of other impurities, such as phosphorus, which is deleterious, is usually small, and does not make up an important volume of the mass. Whilst such is the general composition of brown ores, they vary much in physical appearance with the geological formations, from which they are derived.

There are three distinct geological horizons, in Polk county, which contain brown ores. The greatest volume of the ore occurs in the Knox dolomite formations; some of the most valuable ore occurs in the Iron-Limestone division, above the Maclurea division; and other deposits are associated with the Lower Carboniferous chert beds.

THE ORES OF THE KNOX DOLOMITE FORMATION.

The ores associated with the Knox Dolomite formation have been derived from the weathering of those rocks, whereby the calcareous matter has been leached out. By this process, when the rocks consist of the purer limestone and dolomite, there remains only clay, and the iron ore, which was originally in the form of the carbonate or the sulphide. Under these conditions, we find that the ancient limestones have given rise to valleys and subordinate ridges, whose degradation has been checked by the enduring accumulation of the ferruginous gravel and boulders. The more siliceous beds, after the calcareous matter has been leached out, leave prominent ridges of clay and sandy earths, commonly covered with chert; and some unimportant deposits of brown ore. Such, especially arise, from the decay of the cherty layers of the higher beds of the Knox formation. Accordingly, it is from the more calcareous beds that the greater volume of the ore was derived. As might be expected, the red presence of the iron has left evidence of itself, which has colored most of the ore bearing hills, a contrast to the gray cherty ridges, although the former contain numerous "horses" or pockets of clay of white or light purple color.

The red banks, which contain ore in greatest quantities, are most commonly situated near the border of different geological formations: or where the geologically lower and more ferruginous beds of the Knox series appear at the surface; owing to either erosion or to their repetition by geological faults. This holds true, whether the more ferruginous beds pass under the overlying Silurian rocks or not, for the accumulation of iron has largely resulted from concentration occasioned by the removal of calcareous matter from the original rocks—this action only taking place when they are exposed to surface weathering. Hence, the great economical importance of knowing not merely the horizon of the ores, but also of the mapping of the boundaries of the districts occupied by each formation. Thus, in the western part of the county, the deposits of Etna, Oredell and other places, near the junction of the Knox formation with the underlying Cambrian formation, is characterized by valuable ore deposits. With Cedartown, as a focus, there is a parabolic curve of ore deposits extending southward. There is a similar occurrence in the Fish creek district, and again northwestward of Rockmart. All of these ore ridges belong to the

Knox dolomite, and are within comparatively short distance of the valley making and overlying Maclurea limestone, as shown on the map. This distribution is accordingly adjacent to the valleys and embayments, which appear to have been the most favorable conditions for the accumulation or concentration of the iron. Upon all the ridges, even those covered with chert, more or less important deposits of ore are liable to be found.

The physical condition of the ore deposits is variable. They occur in small concretionary masses and grains—"wash-ore"—throughout the clay; and in masses from large concretionary boulders, in some cases, to great irregular pockets, almost assuming the form of beds. Again, they occur in irregular beds, but when such is the case, its value is greatly reduced, as they are usually only richly ferruginous chert of too low grade for profit. The wash-ore and the massive boulders are, more or less, accumulated into irregular pockets interrupted by clay "horses," beneath which the ore banks or pits are not often opened. Sometimes, however, these deposits of ore are in the form of great irregular beds, and may be seen passing beneath the "horses," as in an old ore-digging near Oredell.

On some of the red hills, the presence of the ore is indicated by ferruginous gravel or blocks, strewn upon the surface. Sometimes its presence is only indicated by the red clay. The superficial covering of the ore may vary from a few inches to several feet in thickness, and contains enough iron pebbles to repay its removal, when washers are used. In the richer part of the deposits, the appearance to the unpracticed eye, is not always promising, but yet the accumulation may prove rich enough for the separation of the ore to be made by the more extravagant method of screening; when it sometimes happens that even three or four tons of clayey matter can be removed for one of ore obtained. But when the ore is washed, it is usual to work over all the superficial dirt, and a very small percentage of iron can thus be concentrated with a good resulting product. In the case of massive ores a larger per cent. of available mineral is necessary to cover increased cost of operation.

THE ORES IN THE VALLEY OF THE E. T., V. & G. RAILWAY.

Continuations of the ore ridges of Alabama cross into Polk county, at Etna, and extend northeastward, as a chain of ridges along the eastern side of the valley, upon whose western side there are slate ridges. The mines upon the State line contain the most massive deposits of brown ore seen. In these workings, apparent bedding was observed in a disturbed condition, almost as if there had been some great line-sink into which the roof of a former cavern had fallen, in heterogeneous masses. The ore has a different physical

appearance from that of the Cedartown district, having a more massive and less concretionary form, in which are conspicuous fragments of decayed flinty matter. Upon the supposed Alabama side of this deposit, the ore has been worked to a depth of sixty or seventy feet without reaching its base. On the Georgia side the workings have not reached such a depth.

From Etna, a chain of pits continues northeastward to Wood's and other banks near Pryor. Farther northward, there is a large assemblage of banks at Oredell. Near this point there are contact disturbances between the different geological formations. Some of the extensive ore banks at Oredell are typically like the general red banks of the Knox series; but again, others are more less connected with chert beds, which cover many of the ridges. Some of these ore banks are very extensive. In boring for an artesian well at Oredell, a development of one hundred and eighty feet of ore deposit was found beneath the bottom of the valley. A little beyond Oredell, the geological disturbances dislocated the formations, but after a gap of about two miles, the chain of deposits continues to near the northern county line, upon the eastern side of the railway. On the western side of the railroad, there is a basin of Knox Dolomite thrown westward between the ridges of Cambrian rocks into a trough about two miles westward of "Hematite" Siding. In this narrow basin, there are valuable ores of usual type, and also siliceous deposits. In one place, the ore was found lying beneath a clay "horse." Some of the siliceous ore might be regarded as extensive ferruginous cherty beds. There are also found iron-manganese ores. The "Hematite" (Linton Spark's) and the Stot Folger ore deposits embrace the principal iron beds exposed here.

ORES IN THE CEDARTOWN DISTRICT.

These very extensive ore banks usually occur upon subordinate ridges, rarely rising to one hundred feet above the valley. They occur adjacent to the boundary of the Maclurea limestone, forming the valley. Such is the position of the disconnected ore ridges, which are extensively found around the margin of the newer limestone formation. The largest workings are those situated two or three miles westward and southward of Cedartown, and constitute a chain of ore banks, as for instance, the Reed, Ledbetter, Peek and Wood mines.

The relative amount of the ore and the prevalence of "horses" vary in importance. The ore is known to have a depth of not less than forty feet in some places. It is mostly composed of fine concretionary material or "wash ore," with only a moderate quantity of massive blocks. In one part of the Peek mine, the ore approaches the appearance of bedding, and near by, there is an exposure of ferruginous chert, forming an extensive bed or cliff. In some cases,

these hills are covered with ferruginous gravel; in others the surfaces are covered with red clay containing fine concretionary ore, which is sufficient to justify the washing of the mass.

Southwest of these beds, other ore ridges, as those of Rice's bank and Brewster's mines, near Esom Hill, form a continuation of the chain extending southwest of Cedartown. North of Cedartown we find again, the continuation of the same condition at Waddell's bank, and at other pits near by. South of Cedartown, the Central Mining Company owns several banks east of Judkin's mills; southward of which occur the Cleveland, Pittman, Cox and Ray banks, containing considerable quantities of ore.

FISH CREEK DISTRICT.

At the northern end of this district, near Grady, there are two very extensive series of ore banks, the one belonging to the Cherokee Iron Company, and the other to the Central Mining Company. The occurrence of the ore here is identical with that in the Cedartown district, but the ridges are rather more elevated. Southward and on the peninsular tongue of Knox Dolomite, between Maclurea limestone exposures, there are various extensive deposits of ores, such as those of Hickman's or Simpson's mines (lot 1,015 21st district); of W. O. Morris' (lots 1,088, 1,133), and of Mrs. Morgan's and Mr. Winn's (lot 1,060, 21st district).

DISTRICT NORTHWEST OF ROCKMART.

On the red hills of the Knox Dolomite ridges, near Long Station (E. T., V. & G. R'y), northwest of Rockmart, adjacent to the junction of the Maclurea limestone valleys, there are several very large ore deposits. Those near Long Station belong to the Central Mining Company; and beyond are the Randall and Cochrane mines. The general condition is similar to that at Cedartown. Between these deposits and those southwest of Rockmart, in which one would expect to find ore banks, there appears to be a considerable gap.

NOTE.—The ore ridges are usually subordinate to the great ridges of the Knox formation. Whilst the trend of the chain of ore hills may be often that of the general ridges of the country, yet the individual ridges have a direction frequently at right angles to the general trend. In the proximity of the ore deposits, to the edge of the Knox Dolomite formation, they may be frequently a mile or two distant; or they may rise as insular ridges through the newer formations.

ORES OF THE IRON-LIMESTONE SERIES.

The exposures have already been described. Whilst portions of the bed are still partly calcified, yet the greater proportion of the

beds, as at present known, are almost entirely converted into iron ore, which is much sought for. This chain of ore deposits is situated above the Maclurea limestones and beneath the slate beds, to the south-eastward. The largest of these deposits appears to be that at the Deaton (Couper) mine (lots 81 and 64, 18th district), where the limestone formed the roofs of great caverns, which, in collapsing, have produced heterogeneous heaps of ore filling the old chambers. In this mine, the ore is known to have a depth of forty feet at least, intersected with the limestone walls of the ancient caverns. The whole mass of fallen material is a workable ore deposit.

The Central Mining Company has similar deposits on and adjacent to lot 1076, 18th district. The ore beds are continuous and are known to reach to a depth of twenty feet, but are covered by from four to eight feet of ferruginous clay.

Similar deposits are found on lots 784 and 728 (Carleton), 873 (Haton's) and 928 (Jones'), all in the 18th district.

The ore is entirely unlike that of the Knox group. The material is limonite and usually of a yellowish color. The more desiccated and redder varieties are frequently magnetic. This is scarcely to be wondered at, as the rock is slightly metamorphic, and thus it would appear that the iron ore dates its origin to a time anterior to the metamorphism of the slates which probably overlie these beds farther south. The material of the ferruginous earth, in some respects, resembles other iron-bearing earths of the county, but the pebbles and iron-ore blocks contained therein are fragments of laminated rocks, and not concretions. Some of the intercalated ore layers are converged into a soft ochre deposit, as is also the case with some of the overlying beds.

ORES OF THE LOWER CARBONIFEROUS CHERT.

About six miles southwest of Cedartown, on Mr. West's and adjacent properties, there are brown ores associated with chert masses. On lot 324 of the 2d district we find the siliceous ore in beds. These deposits are on the northwest side of the ridge, and in proximity to the junction line between the different formations. This ore has a peculiar character of its own, somewhat approaching hematite in its appearance, and is very compact. The quantity is considerable, but there have been no workings, nor have I seen any analysis of these ores.

ANALYSES OF THE ORES.

In many places, manganese in small quantities is associated with the brown ore. Occasionally zinc is also included. Very little sulphur is present. The phosphorus varies even in neighboring pits. Or-

dinarily, it is in sufficiently small proportion to not interfere with the use of the ore. The average quantity of metallic iron in the extracted ore usually exceeds fifty per cent., and the reduction of the quantity of the metal arises from clay and sand that is not entirely separated from the ore, which is everywhere in demand.

ANALYSIS OF POLK COUNTY ORES FOR THE CHEROKEE IRON COMPANY.

BY ERNST. SJOSTEDT, CHEMIST.

	I.	II.	III.	IV.	V.	VI.
Silica.....	8.01	15.95	9.27	12.18	10.60	10.19
Alumina	13.21	17.01	41.48	5.52	3.71	6.85
Oxide Iron	70.57	57.00	78.85	71.28	80.14	75.14
Lime.....	1.27	1.13	1.61	2.99	1.49	2.41
Magnesia.	0.42	0.22	0.48	0.50	0.11	0.41
Manganese	0.12	0.93	0.40	0.27	0.38	0.35
Phosphoric Acid.....	0.58	2.17	0.91	1.11	0.88	1.00
Water.....	5.01	4.88	4.20	6.08	3.08	3.51
Iron	49.40	39.90	55.00	49.9	56.1	52.6
Manganese	0.09	0.72	0.31	0.22	0.22	0.27
Phosphorus.	0.253	0.949	0.399	0.491	0.386	0.438

No. I. Roasted ore from Grady's Bank. II. Roasted ore from Peek's Bank. III, V, VI. Ores used on three succeeding days in furnaces. IV. Washed ore.

These iron ores, being variable, yield metallic iron, containing from 0.20 to 0.75 per cent. of phosphorus.

THE COMPOSITION OF THE ETNA ORES,
as shown by the analyses furnished by Col. Hamilton:

	Per cent.
Iron sesquioxide.....	81.26
Manganese sesquioxide.....	0.43
Alumina.....	1.12
Lime.....	0.12
Silica.....	5.79
Water.....	11.45
Phosphorus.....	0.05
Sulphur.....	0.01
	<hr/>
	100.23
Metallic iron.....	56.88

The analyses of the ores obtained at eleven other ore banks yielded :

	Per cent.
Metallic iron, from.....	58.45 to 51.10
“ manganese, from.....	0.20 to 5.60
Silica, from.....	2.40 to 7.87
Phosphorous, from.....	0.147 to 0.858

One analysis showed 16.39 per cent. of silica. Another analysis gives 1.396 per. cent. of Phosphorus, which generally falls below half of one per cent. The above analyses were made by L. S. Clymer, in the labarotory of Messrs. Cooper & Hewitt, Reegelsville, Pa.

The analysis of the iron produced in May, 1890, showed the presence of :

	No. 4.	No. 5.
Silicon.....	0.253	0.337
Manganese.....	0.144	0.124
Phosphorus.....	0.412	0.393
Sulphur.....	0.000	0.000

THE ANALYSIS OF THE ORES FROM DEATON (COUPER) MINE IN THE IRON-LIMESTONE SERIES.

	I.	II.
Metallic Iron	48.56	49.32
Silica.....	14.25	11.04
Phosphorus.....	0.363	0.335
Sulphur.....	Trace.
Titanium.....	0.011
Water.....	1.30	2.53
Lime.....	0.73

One individual analysis gave iron 53.12 per cent., and others showed the phosphorus below 0.3 per cent.

Whilst zinc minerals were not observed along with the iron ores in the field, yet their presence is demonstrated by the accumulation of zinc sublimates beneath the funnel of the furnaces. Thus, when the Cherokee furnace, at Cedartown, was blown out about 1880 (at that time, a charcoal furnace) about twenty thousand pounds of a product of the following composition was found accumulated under the funnel.

Zinc oxide.....	82.443 per cent.
Alumina and iron.	3.700 per cent.
Coal dust.....	3.140 per cent.
Alkalies (by difference).....	9.857 per cent.
Sulphur.....	0.203 per cent.
Cadmium oxide.....	Trace.
Insoluble matter.....	0.660 per cent.

FURNACES.

In Polk county, there is a furnace at Cedartown—Cherokee Iron Company—whose capacity reaches twenty thousand tons a year. It has been in operation for many years, having been originally built as a charcoal furnace. The product is a high grade of foundry iron. One other furnace occurs in the county, the Etna furnace, situated near the Alabama line. This is a charcoal furnace, with a capacity of about ten thousand tons a year. Just over the Alabama line, there are also extensive ore deposits and several furnaces.

THE ORE PRODUCT.

Two furnaces thus named, when running full time, consume nearly sixty thousand tons of ore a year. Nearly 200,000 tons of the Polk county ores were shipped (in 1890) to Alabama and Tennessee. There is a constant demand for the brown ores, as they are much sought after for mixing with other kinds of ore. They command a good price.

Until comparatively recently very little ore was shipped or used; except such as could be screened, as washers were not then introduced. This was due to the mining operations being generally performed by small contracts. Nowadays, the larger companies have put up improved washing machinery, whereby a greater yield, at lower cost, is obtained, and, at the same time, a better quality of ore. The cost of mining varies greatly. In one case (the Deaton mine), the ore is put on board the cars at fifty cents a ton; in other cases, as much as a dollar a ton is paid for the cost of raising. The net price received for the ore varies—about one dollar and fifty cents per ton. This last price is that obtained at the Deaton mine, which is shipping two thousand tons per month.

NOTE ON THE ORE DISTRIBUTION.

In the references to individual mining properties in the preceding pages, the notice of them was incidental, as being the easiest way of locating important positions. Many of the named companies possess considerable numbers of ore banks. There are also many unnamed deposits of value, situated in the general belts, whose position is easily recognized along the chains of ore banks named. Outside of these general belts, on many of the chert hills, there are numerous deposits of ore, but not in sufficient quantities to be of value, although here and there, some may yet be found of value.

OCHRE WORKS.

There is in process of construction, at Rockmart, an establishment for the manufacture of ochre and other paints from the abundant ferruginous clay.

MAGANESE ORES.

There are several localities in Polk county, where oxides of manganese occur, but there is no mining, although just beyond the limit of Polk, in Floyd county, a large mine is now being operated by Mr. Couper. Accordingly, the consideration of manganese ores scarcely falls within this report. Still, it is proper to add that the manganese occurs in the Knox Dolo nite ridges more or less associated with the partially disintegrated rocks, as well as in the risidual clays like the richer deposits of iron ore. Hence, the manganese often occurs in the gray ridges. Deposits are found south of Cave Spring. Near the county line, about seven miles north of Cedartown, manganese occurs upon the property of Mr. Stokes. About a mile from Hickman's mines, on the farm of Mr. G. W. Morgan, manganese was also found. Again, in the valley near "Hematite," a mixture of iron and manganese was seen. The superficial indications are frequently confined to black or dark bluish stains, owing to manganese powder being mixed with the clay. Pockets of manganese ores also occur at Etna, yielding from 45 to 50 per cent of metal.

CHAPTER XXI.

BUILDING MATERIALS.

LIMESTONES.

The Maclurea limestone is a compact, fine grained rock, varying from a light bluish to a dark bluish gray color; indeed, it is a sort of a marble. In numerous places in the valleys, which have been described before, the limestone is available for unlimited local use, but as it is situated near the drainage level, it could not be quarried cheaply enough for extensive shipment, as there are some points in the county, which are more favorable for its extraction. Near Rockmart, and northeastward, there are many ridges which are particularly favorable for the working. Thus, at Devitte lime ridge, about five miles northeast of Rockmart, the rock is but thinly covered with earth and the quarries have a vertical face of forty or fifty feet. The location is very favorable for its cheap extraction, and large quantities have been shipped for furnace purposes, at forty-five cents a ton. In this region, there are various other available lime ridges. The quality varies somewhat between the different ridges, but they are of high grade, either for furnace purposes, or for lime, as may be seen from analyses on page 110 of this report.

As a building stone, it is good, and many portions of the beds have a beautiful color. It is a wonder that more of it has not been used in competition with granite. Its hardness has, no doubt, to some extent interfered with such use, as it is more difficult to work than many other limestones, but yet it is much softer than granite, and quite as durable. It contains but little iron, and therefore does not change its color.

SLATES.

As a geological formation, the Nashville or Rockmart slates have already been described. As an economic product, only the ridges, can form suitable locations for quarries. The slates in the ridges are hard, and are frequently very little affected by weather, except the thin surface coating. At other times, the surface slates are weathered to a depth of twenty feet. In many localities, the slates are consequently unavailable, or where available, they are found to be unsuitable for splitting. But in the ridge at Rockmart, good cleavable slates

have been quarried for many years. When viewing the vast heaps of waste material, unfavorable impressions might at first be formed, but the wastes in every slate quarry are equally large. These, however, might be somewhat reduced with more systematic methods of working. The available slate deposits at Rockmart belong to various individuals, and the quarrying could be more effectively carried on if the boundary lines were removed by a combination of interests. The three principal owners are Col. T. F. Dever, the Seaborn Jones estate, and the Rockmart Land Improvement Company.

At Rockmart, a variety of banded indurated clay is found. This can be sawed, carved or turned, is of a yellowish color, and capable of manufacture into a variety of ornamental work. When ground it makes a mineral paint.

BRICK CLAYS.

The clays of the county are not everywhere suitable for brick purposes. Those of the red hills contain too much iron, and of the gray hills too much sand, still, fair bricks are obtained from some of the valley deposits, which appear to have a swampy origin, and from these the best local bricks are made.

SANDSTONE.

Ordinary sandstones do not occur in Polk county. Southeast of Esom Hill, a compact quartzitic rock is found. On Indian Mountain, there is abundance of beautiful fine-grained quartzite. This is a metamorphic sandstone. It occurs in beds of any desired size. Whilst a most durable rock, its great hardness makes it a costly building material. Beds of cherty rock occur. These, however, could not be used as a good building material; but when broken up, or when the loose surface fragments are obtained, they make serviceable macadam for roads. Such deposits of chert are widespread.

CHAPTER XXII.

THE SOILS.

A report upon the value of the soils in the different belts cannot be given, as the assistance of a chemist for analytical work has, so far, not been available; however, the general distribution of the soils and their relation to the geological formations can be stated. The popular classification of the soils, into gray and red lands, is somewhat misleading, and is not sufficiently specific, for the character of the gray and red lands of the Palaeozoic formations of Polk county are entirely different from those of the metamorphic formations of Middle Georgia, or, again, those of South Georgia. The soils of Northwest Georgia have been derived from schists, slates and limestones, but these have produced varieties depending upon their origin.

THE CAMBRIAN SOILS.

These do not form a large factor in the agricultural features of Polk county, as they occupy but a few square miles in the northwestern part. The soils amongst the sandstones of Indian mountain are confined to more or less isolated patches. Farther down the slopes, the slaty ridges are covered with a thin soil, but lower still we have the valley of Etna, etc., more or less composed of soils derived from the Upper Cambrian shales, which are of good quality as the shales were more or less calcareous.

THE KNOX DOLOMITE AND OTHER SOILS.

These are of two characters—the valley red lands and red hills; and the gray ridges and cherty hills. The former of these classes constitute some of the best lands in the State. The cherty gray uplands are often of inferior quality. We find the red lands more largely developed in the southern than in the northern part of the county. The red valley lands in the southern and eastern part of the county often graduate into the limestone valley lands of the overlying Maclurea division; these, together, constitute our best soils.

Overlying the margin of these fertile limestone lands, there are the several districts occupied by the Nashville slates. These soils are sometimes of good quality, but very often they are thin and indifferent.

On the metamorphic ridges of Dug Down mountain, we have indifferent soils overlying the slates, which often come to the surface.

From this brief description, it will be seen that the soils in the county are very variable, from some of the best lands in the State to others which are indifferent. However, all of the cherty ridges derived from the Knox Dolomite could not be classified as poor land, although some of them are very light and indifferent. The cherty gravel is superficial, and when the country comes to be more densely populated, these stones will be removed as is done elsewhere.

THE TIMBERS.

The most valuable timbers are the oaks and the pines, which still exist in considerable quantities, although where near to railways, they have been largely cut off; still, there are many ridges which are yet uncultivated, and in their almost original condition, and support a sufficient supply for local manufacture and other uses.

CHAPTER XXIII.

WATER-POWERS.—ROADS.

WATER-POWERS.

A number of small water-powers, which, however, have a great head of water, are found along the slopes of Dug Down mountain; such as those of Hightower mills, and Simpson's mills, where the fall reaches forty to sixty feet, and more, thus giving power to the comparatively small streams. Several other small powers are scattered throughout the county, such as at Judkin's and Young's mills south of Cedartown, and at Rockmart and Cochran's mills in the north-eastern part of the county.

ROADS.

Throughout Polk county the valley roads have often good grades, but over the ridges they are often steep. The roads over the slaty formations are usually good. Those over the decayed limestone formations are liable to be cut in deep ruts during the wet seasons. The roads over the more cherty formations are more certain. Owing to the various distribution of chert, and the limestones, valuable material for road-making would be available in many places.

GEOLOGICAL SURVEY OF GEORGIA

W. S. YEATES, State Geologist

ADMINISTRATIVE REPORT

OF THE

STATE GEOLOGIST

From October 24th, 1894

To October 15th, 1896, Inclusive

ATLANTA, GA.

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EXHIBIT OF GEORGIA BUILDING-STONES, IN THE STATE MUSEUM.

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ADMINISTRATIVE REPORT

GEOLOGICAL SURVEY OF GEORGIA,
ATLANTA, October 16th, 1896.

*To His Excellency, W. Y. ATKINSON, Governor, and President of the
Advisory Board of the Geological Survey of Georgia,*

SIR: — I have the honor, to submit my administrative report, covering the period, from Oct. 24th, 1894, to Oct. 15th, 1896, inclusive.

On account of the demands made upon my time, by the collection and installation of the State's exhibits of Minerals and Forestry, at the Cotton States and International Exposition, in addition to the regular duties of State Geologist, the usual annual report was omitted, last year; and this, therefore, covers the period, since my report for 1894.

The administrative work of the office has steadily increased, with the existence of the Survey; and, on account of the part, taken by the State, in the Cotton States and International Exposition, held in Atlanta, from September 18th to December 31st, 1895, this work was largely augmented. As the duties of the State Geologist are both administrative and executive in character, it is not easy to divorce them completely, in a report of this kind. A greatly increased official correspondence; the disbursement of the finances of the Survey; the planning of a suitable exhibit to illustrate the

State's mineral and forestry resources; the designing of proper methods and means of installation, to best carry out these plans; the selection and employment of competent assistants, to aid in their execution; the reviewing and editing of reports, submitted by the Assistant Geologists and the Topographer; the supervision of all details of printing, lithographing and engraving; the classification and installation of collections, both at the Exposition and in the State Museum; the identification of specimens of minerals and ores, for persons living in various sections of the State; and the numerous details, incident to the conduct of the office, have all required my personal attention.

EQUIPMENT

The facilities for work have been much improved, since my last report, by a number of additions to the equipment of the Geological Survey. A good assay-plant has been established in one of the rooms of the chemical laboratory, and a machine for trimming mineral and rock specimens has been added to the geological laboratory. The old mineral storage-case, mentioned in my last report, as being practically useless, has been removed, and two excellent cases have been built, in its stead; one, 24 feet, 3 inches, and the other, 7 feet, long, containing drawers, with room, sufficient, to accommodate a large number of specimens. These cases are divided into tiers, and are so built, that any drawer will fit in any part of either case, the drawers being of various depths. The tops of the cases are made in the form of tables, on which minerals, ores etc. may be classified and arranged. These cases are built of oak, finished in hard-oil, and the drawers, of white-pine, shellacked inside and out.

The microscope, which was referred to, in my last administrative report, as being out of order, I have had repaired, at a small cost; and it proves to be an excellent instrument. One hundred and forty-four additions to the library have been catalogued, during this period, the last catalogue number being 323.

To the field equipment, has been added a large surveyor's transit, a 50-foot steel tape, three hand-picks, and one 5 x 7 "Kodak" camera. In my last report, I failed to mention, as a part of the equipment, two 5 x 8 cameras, in good condition, and one, of the same size, in very bad condition. This last, and one of the other two mentioned, I found in the office, at the beginning of my administration.

Of the five horses belonging to the Survey, when I came into office, two of them were worn out, and practically unfit for use. These were sold at auction, by the Advisory Board, about the close of the year 1894, and the money was applied to the purchase of two new ones. Since then, two of the old horses have died, from natural causes, and another new one has been purchased, making four horses now belonging to the Survey.

PERSONNEL OF THE SURVEY

Mr. S. W. McCallie, Assistant Geologist, still remains with the Survey, and is doing good work. Mr. F. P. King resigned the position of Assistant Geologist, to take effect on the first of April, last. As a successor to him, I appointed Dr. George E. Ladd, who had received, successively, the degrees of A.B., A.M. and Ph.D., at Harvard University, and had spent considerable time, in study, at some of the German Universities, principally at that of Munich. Dr. Ladd had been Assistant in the Geological Department at Harvard,

for two years, and Instructor in Geology, in the Summer School of the same institution, during the same period. He was Assistant Geologist on the U. S. Geological Survey, for about three years; Assistant Geologist on the Survey of Texas, for about six months; and First Assistant Geologist on the Geological Survey of Missouri, for two years. He collected and arranged the collection of building-stones and minerals, displayed by the State of Massachusetts at the World's Columbian Exposition, at Chicago, in 1893. Dr. Ladd has done considerable work, both in economic and general geology, and has published a number of papers and reports, with maps, on the subjects, which he has studied. In addition to his duties as Assistant Geologist, I have found it necessary to employ him in chemical work, as far as his time would permit, he being, by special training, thoroughly competent for such service.

Of the gentlemen employed for special work, during this period, Mr. D. Lee Wardroper, of Gainesville, Ga., was employed for about seven months, as Topographer, in charge of a topographic survey of a small portion of the State, which will be referred to, further on in this report. Mr. B. M. Hall, C. and M.E., was employed, to compile a report on a part of the water-powers of the State, from the notes, left by Mr. C. C. Anderson, Assistant State Geologist under my predecessor. Mr. R. L. Packard and Mr. Walter L. Mitchell were employed for two or three months each, as chemists; and Dr. Geo. E. Ladd, now Assistant Geologist, was employed, for a short time, as Chemist, prior to his appointment as Assistant Geologist. Messrs. F. B. Ivey and John W. Jones were employed as Assistants to the Topographer, who also employed an axe-man, while in the field. Mr. Frank E. Ellis was appointed Stenographer to the Survey, April 1st, 1895, his services being furnished, in accordance with the Act of the Legislature, by the Commissioner of Agriculture. All these gentlemen have rendered satisfactory service, and have contributed to the success of the work of the Survey.

THE MINERAL AND FORESTRY EXHIBIT COTTON STATES AND INTERNATIONAL EXPOSITION

At the request of the STATE EXHIBIT COMMISSION, COTTON STATES AND INTERNATIONAL EXPOSITION, I assumed charge of the work of collecting and preparing exhibits, which would show the State's mineral and forestry resources. The appropriation was made in December, 1894; but it was the first of April, following, before assistants could be employed and the work, begun. By consent of the State Commission, I collected material, in duplicate, in order to make a complete display, in the Mining and Forestry Building, as well as in the State Building, thus exhibiting Georgia's resources alongside of those from the other Southern States.

Mr. W. M. Brewer, of Canton, Ga., was employed to collect the minerals, ores etc. of the State; Mr. C. H. Mayhew, of Atlanta, to collect the building-stones; and Dr. John K. Small, of the Herbarium of Columbia University, New York, to collect the forestry exhibit. Mr. G. C. Moore, of Littleton, N. C., formerly of the Mineral Department, U. S. National Museum at Washington, was appointed Preparator, and Mr. R. L. Packard, of Washington, D. C., Chemist.

BUILDING-STONE EXHIBIT

Mr. Mayhew began field-work, April 1st, to collect, under my direction, a suitable exhibit of the building-stones of the State. After as much field-work, as the limited time would permit, had been done, Mr. Mayhew, with a number of stone-cutters, was put to work,

to polish and prepare this exhibit; eight-inch cubes, dressed on all faces, in the various styles used by builders, having been adopted by me, as the best method of showing the superior qualities of the building-stones of the State. As far as the limited time would permit, Mr. Mayhew was able to collect material for forty-three cubes, with their duplicates, and one triplicate, representing different stones and different localities throughout the State; the Georgia Marble Company contributed five dressed cubes, in duplicate; and the Southern Marble Company, one dressed cube, a duplicate and a triplicate; making, in all, one hundred specimens. One of the duplicates, a specimen of gneiss, I assigned to the reserve exhibition series, in order to show two polished faces of the same material, one with, and the other across, the laminated structure, presenting very different appearance. One of the duplicates from the Georgia Marble Company, I assigned to the same series, because it varied, to so great an extent, from its original. One of the specimens, collected by Mr. Mayhew, with its duplicate, proved to be worthless; and it was rejected. Nine other duplicates proved bad, on working; leaving only 37 cubes for the duplicate series.

These specimens were exhibited in the Mining Building and the Georgia State Building, at the Exposition, mounted on ebonized wooden blocks, and displayed, in each building, on a square, stepped pyramid, covered with heavy, brown cloth. A handsome contribution of six slabs, 4 x 6 feet, of their mottled, pink, white and gray marbles, was made to the State Exhibit, by the GEORGIA MARBLE COMPANY of Tate, Georgia. Besides these, this company generously contributed five dressed cubes, with their duplicates, of the same marbles, to the systematic building-stone collection. Among other exhibits of this character, mention should be made of the large brown sand-stone specimen, furnished by the Southern Brown-stone Company, from their quarries near Graysville, Catoosa county. One of the most unique exhibits, made at the Exposition, was that, which

PLATE II.



VIEW IN THE STATE MUSEUM, SHOWING CASES OF THE SYSTEMATIC SERIES OF MINERALS, AND SLABS OF GEORGIA MARBLE.

was made, in the Georgia State Building, by the SOUTHERN MARBLE COMPANY of Atlanta, Georgia. It consisted of a solid block of white marble, from their quarries in Pickens county, 22 feet, 6 inches long, by 4 feet, 4 inches wide, by 2 feet, 6 inches thick, weighing 45,200 pounds, with one side rough from the channelling machine, and the other, "pointed". This was mounted, about ten inches from the floor, on wooden blocks, painted black, the "pointed" side, to the front. On top of this, rested a handsomely-dressed plinth, about 8 feet long, by 2 feet high, by 2 feet thick; and, on this, was a smaller plinth, on which rested a handsome, polished sphere, 3 feet 11 1/2 inches in diameter. Another plinth, differently dressed from those mentioned, had to be left off, because the ceiling of the hall was not sufficiently high, to admit of its being mounted with the others. This was placed on blocks, near the main exhibit. This costly display of Georgia marble was specially prepared, for the Georgia State Exhibit, by the Southern Marble Company; and all expenses, including its installation, were generously borne by this company. At the close of the Exposition, this superb exhibit was presented to the State Museum, by the Southern Marble Co.; but, on account of its magnitude, and for want of a suitable place, to exhibit it, the Geological Board found itself unable to accept the gift. Special mention should, also, be made of a number of monuments of granite and marble, kindly loaned to the State by the Cherokee Marble Company and Messrs. Newman & Neri, both of Atlanta; and of a handsome slate exhibit, from the quarries of the Georgia Slate Company, at Rockmart, contributed by this company. Mr. A. O. Venable of Atlanta, also, loaned us a monument of Lexington Blue Granite from Lexington, Ga., and a large carved and polished slab of Stone Mountain granite, from that remarkable granite mass, the Stone Mountain, in this State.

MINERAL AND ORE EXHIBIT

Mr. W. M. Brewer visited most of the mines, collecting a large quantity of material, consisting of miscellaneous minerals, gold ores, iron ores, manganese ores, aluminum ore (bauxite), tripoli etc. In addition to the work done by Mr. Brewer, I myself went into the field, and assisted in the collection of the minerals; and during the month of August, I, also, sent out Mr. F. P. King, Assistant Geologist, for the same purpose. These specimens were displayed, at the Exposition, as follows:—

A.—THE SYSTEMATIC SERIES OF MINERALS, in six special slope-top, mahoganized cherry and plate-glass cases, eight feet long, modelled after those used in the U. S. National Museum at Washington, for exhibiting the same class of material, five of these being in the Georgia Building, and the other one, in the Mining and Forestry Building. In addition to the specimens, collected by Messrs. Brewer and King and myself, there were, in this exhibit, a number, which had been kindly loaned, by various friends in the State, to whom acknowledgment is made, elsewhere; and a few, which I had selected from the material, formerly collected by the Geological Survey, under the administration of one of my predecessors, and more recently exhibited in the display-room, connected with the Department of Agriculture; also, some, which had been collected under my immediate predecessor, and by my own Assistants on the Survey, in the discharge of their regular duties.

B.—THE ORES, ABRASIVES ETC., on nine special tables, covered with brown cloth, classified, according to their economic uses, five of the tables being in the Georgia Building, and four, in the Mining and Forestry Building. A number of large speci-

mens were displayed on maroon-and-black wood-bases, modelled after those, in use in the U. S. National Museum. A large quantity of pyrite, in lumps, used for the manufacture of sulphuric acid, was contributed by the Chestatee Pyrites Company of Atlanta, from their mine near Dahlonega. This was made into an attractive pyramid. A considerable quantity of limonite, furnished by the Chattahoochee Land Company, from their mine in Cherokee county, was also made up, as a pyramid. A special exhibit was made, in the Georgia Building, by the Howard Cement Company of Cement, Ga., in the form of a square base of the rough stone, cemented together, surmounted with a pyramid of cement. Around this, were several barrels of their product, in the crude state. A very attractive display was also made in this building by the Bowden Lithia Water Company of Atlanta, in the form of a large pyramid of bottles of mineral water, from the Bowden Lithia Springs at Austell, arranged according to size.

In the Mining Building, was displayed a large rectangular column of coal, from the Chickamauga Coal & Iron Company, whose mines are located in Walker county.

Special mention should be made of a remarkable collection of fine gold specimens, consisting of nuggets, gold sponges from amalgam, gold in quartz etc., made up from loans, made by Mr. R. K. Reaves of Athens, Mr. John Martin of Cleveland, Mrs. J. Belknap Smith of Thomson, and Mrs. W. A. Charters and Capt. J. W. Weaver of Dahlonega; and by Mr. Christian Wahl of Milwaukee, Wisc., and Judge W. W. Murray of Huntingdon, Tenn., both of whom are owners of large interests in Georgia gold mines. This was, by far, the most beautiful and valuable gold exhibit, displayed at the Exposition, and may be summarized as follows:—

	Number of Specimens.
Gold Nuggets, varying from 5 to 60 dwts. (29 oz.)	75
“ “ (weight, 83 dwt.)	1
“ “ (weight, 34¼ dwt.)	1
“ “ (weight not ascertained)	3
“ Sponge from Amalgam (33 ounces)	2
Free Gold in Quartz	97
“ “ in Galena and Quartz	2
Total	181

The Survey is greatly indebted to these friends, for their generous help. The exhibit attracted a great deal of attention, and was much admired.

We are also indebted to Mr. A. E. Heighway of Murphy, N. C., for the loan of six very handsome, large, cut specimens of amethyst, from Rabun county, Ga. These were of exquisite quality, all being mounted in gold for use as cuff-buttons. Our grateful acknowledgments are specially due to Prof. L. P. Smith of LaGrange, Prof. W. O. Connor of Cave Spring, Mr. T. S. Bean of Clarkesville, Mr. J. C. Williams of Thomaston, and Mr. A. E. Heighway of Murphy, N. C., for loans of miscellaneous minerals; and to Mr. John R. Glen of Cleveland, Ga., for the loan of a collection of Indian relics.

THE ORNAMENTAL STONES, which were included in the systematic series of minerals, consisted of six large mounted amethysts, from Rabun county; a pair of gold-in-quartz cuff-buttons from the Singleton mine, Dahlonega; and a series of moonstones, which were collected by myself in Forsyth county, and cut and polished for display in our exhibit.

All the specimens of minerals, ores, building-stones etc. were labelled, with neatly-printed labels of french-gray cardboard.

FORESTRY EXHIBIT

Dr. John K. Small, specialist in charge of the Herbarium of Columbia University, New York City, who had been highly recommended to me by Dr. B. E. Fernow, Chief of the Division of Forestry, U. S. Department of Agriculture, was appointed, to collect and prepare an exhibit of the woods of Georgia, in duplicate. This he did, most efficiently, beginning May 1st, and, in the short space of time, during the summer months of 1895, he, by great diligence, covered nearly the entire State, and succeeded in collecting almost all the different species, indigenous to Georgia. The woods were collected, crated and shipped to Atlanta, in six-foot lengths of the tree-trunks, great care being taken to prevent defacement of the bark. Two hundred and thirteen specimens, with their duplicates, representing one hundred and fifty-nine species, were exhibited in the Georgia Building and the Mining and Forestry Building, displayed in double-rows, one above the other, on large special bases, one in the former, and two in the latter. These specimens had been prepared in five-foot lengths, half of them being cut vertically through the center, with a half cross-section at the middle, and a half oblique section at the top, showing three different sections through the wood. The upper half of the vertical section was polished; the lower half of the log and the back portion were left, with the bark intact. Fastened to each specimen, was a large neatly-printed label, giving the botanical name of the species, with its various common names, and the locality, from which it was obtained. On one end of this label, was a map of the State, on which was indicated, in green water-color, the distribution of the species in the State. This constitutes, probably, the most complete collection of native woods, that has

ever been made by any State in the Union. It is second only to the celebrated Jesup Collection in the American Museum of Natural History, New York City. It was most unfortunate, that it was necessary to make this collection, during the summer-time, when the sap was abundant in the timber. In consequence of this, considerable of it cracked, on drying out; and some of it became stained by mildew. In order to secure as good a series as possible, for the permanent exhibit of the State Museum, I reserved the finest specimens uncut, to be prepared, after the wood had become thoroughly seasoned. This set is now stored in the basement of the capitol; it will replace the series now on exhibition, in due course of time.

MISCELLANEOUS EXHIBITS

In order to show some of the scenery of the State, I had made five large photographic transparencies of Georgia scenery, which were displayed in one of the large windows in the hall of the Georgia Building, devoted to the exhibition of minerals and woods. Two of these, 25 x 40 ins. in size, were views of Stone Mountain and one of its quarries, and were paid for, by Messrs. Venable Brothers of Atlanta, who very kindly loaned them to the State, for use at the Exposition. The other three, 18 x 30 ins. in size, were views of water-falls etc.

I, also, had made, and displayed among our exhibits, a topographic relief-map of all that portion of the State, which has been surveyed by the U. S. Geological Survey.

SUMMARY OF EXHIBITS

GEORGIA STATE BUILDING

Systematic Series of Minerals	1,089	specimens
“ “ “ Ores etc.	193	“
“ “ “ Building-stones	49	“
“ “ “ Woods	222	“
Exhibit of Granite Monuments and Slabs . . .	6	“
“ “ Marble “ “ “ . . .	17	“
“ “ Slate Tiles, Electric Switch-boards etc.	95	“
“ “ Indian Relics	203	“
“ “ Mineral-water	282	“
“ “ Cement	3	“
Bartow County Exhibit of Pyramid of Unclassi- fied Minerals and Ores	1	“
Unclassified Exhibits of Ores etc. in Pyramids and on Bases, and Other Unclassified Ma- terial	188	“
Total	2,348	“

MINING AND FORESTRY BUILDING

Systematic Series of Minerals	215	specimens
“ “ “ Building-stones	37	“
“ “ “ Ores etc.	141	“
“ “ “ Woods	205	“
Unclassified Material in Pyramids, on Bases etc.	10	“
Total	608	“
Total Number Exhibited in Georgia State Building	2,348	“
Total Number Exhibited in both Buildings . .	2,956	“

In planning for a duplicate exhibit of the State's mineral and forestry resources in the Mining and Forestry Building, it was understood by me, that the State would have ample accommodations for its exhibits; and sufficient material was collected for this purpose, barring a few special exhibits; but, when the space was assigned, it was found impossible, on account of the inadequate size of the building, to give us anything like the space required in the Mining Department of the building, only 397 square feet of space being assigned to Georgia. On account of the arrangement of aisles, this space was badly shaped, for the character of exhibit, which I had planned, it being a combination of a narrow rectangle and a right-angle triangle, the longest side of the quadrilateral being 33.5 feet, and the shortest, 5.5 feet, long. This is mentioned, in order to account for our failure to make the display in duplicate, as originally planned.

ACKNOWLEDGMENTS¹

In preparing the State's exhibits of minerals, ores and building-stones, I was generously assisted in making a creditable display, by a number of friends, throughout the State, and by some, living in other States. Many of these made donations of interesting material, while others made loans of very valuable specimens, with which they could not afford to part, permanently. The following are lists of these friends, with the names of specimens and localities: —

¹ Considerable duplicate material, which was not needed for exhibition, was boxed and stored; and, in consequence, it is not included in these lists. Further acknowledgments will be made, later.



VIEW IN THE GEORGIA STATE MUSEUM, SHOWING THE SYSTEMATIC SERIES OF ORES, AND SLABS OF GEORGIA MARBLE.

RECEIVED AS GIFTS

THE BUFORD MINING CO., BUFORD, GA.

Two specimens of Argentiferous Galena in Auriferous Quartz ; from the Piedmont Mine, Gwinnett County.

Two specimens of Argentiferous Galena with Pyromorphite in Auriferous Quartz ; from the Piedmont Mine, Gwinnett County.

Fifteen specimens of Auriferous Quartz ; from the Piedmont Mine, Gwinnett County.

MRS. J. BELKNAP SMITH, THOMSON, GA.

One specimen of Galena with Auriferous Pyrite in Quartz ; from the Walker Mine, McDuffie County.

Nine specimens of Argentiferous Galena with Auriferous Chalcopryite in Quartz ; from the Magruder Mine, McDuffie County.

One specimen of Free Gold with Limonite after Pyrite ; from the Columbia Mine, McDuffie County.

One specimen of Free Gold with Malachite in Auriferous Quartz ; from the Columbia Mine, McDuffie County.

One specimen of Auriferous Pyrite Altering to Limonite ; from the Walker Mine, McDuffie County.

Four specimens of Auriferous Pyrite in Quartz ; from the Walker Mine, McDuffie County.

One specimen of Native Gold in Quartz ; from the Walker Mine, McDuffie County.

One specimen of Rutile Crystal ; from Graves Mountain, Lincoln County.

MR. J. TRAVIS, CARROLLTON, GA.

Four specimens of Chalcopryite in Hornblende-gneiss ; from four miles North of Carrollton, Carroll County.

Two specimens of Limonite ; from Carroll County.

Six specimens of Asbestos ; from Carroll County.

Seven specimens of Auriferous Quartz ; from Haralson County.

Four specimens of Manganese Ore ; from the Tomlinson Property, Haralson County.

MR. J. T. DEERING, CHESTNUT GAP, GA.

One specimen of Chalcopryite in Quartz ; from the Deering Property, Fannin County.

One specimen of Chalcopryite in Mica-schist ; from the Deering Property, Fannin County.

MR. R. K. REAVES, ATHENS, GA.

Twenty-one specimens of Quartz Crystals; from the Vicinity of Clayton, Rabun County.

Thirteen specimens of Amethyst Crystals; from the Vicinity of Clayton, Rabun County.

One specimen of Smoky Quartz; from the Vicinity of Clayton, Rabun County.

JUDGE W. W. MURRAY, HUNTINGDON, TENN.

Five specimens of Gold in Quartz; from the Preacher Mine, Dahlonega.
One specimen of Auriferous Pyrite in Quartz; from the Murray Mine, Dahlonega.

One specimen of Gold Concentrates; from the Murray Mine, Dahlonega.

Two specimens of Gold Ore; from the Murray Mine, Dahlonega.

THE HAND & BARLOW UNITED GOLD MINING & HYDRAULIC WORKS CO., DAHLONEGA, GA.

Four specimens of Free Gold in Quartz; from the Barlow Mine, Lumpkin County.

Five specimens of Auriferous Quartz and Pyrite; from the Barlow Mine, Lumpkin County.

One specimen of Auriferous Quartz, Interlaminated with Hydromica-slate; from the Barlow Mine, Lumpkin County.

Two specimens of Auriferous Pyrite in Quartz, the Pyrite Altering to Melanterite; from a Street in Dahlonega.

Two specimens of Free Gold in Quartz; from a Street in Dahlonega.

Six specimens of Auriferous Quartz with Pyrite Altered to Limonite; from the Hand Mine, Dahlonega.

Three specimens of Auriferous Pyrite and Quartz in Feldspathic Rock; from the Hand Mine, Dahlonega.

MR. CHRISTIAN WAHL, MILWAUKEE, WIS.

Two specimens of Free Gold with Chlorite in Quartz; from the Findley Mine, Dahlonega.

Thirteen specimens of Free Gold in Quartz; from the Findley Mine, Dahlonega.

One specimen of Auriferous Quartz; from the Findley Mine, Dahlonega.

Two specimens of Pyrite with Hydromica-slate in Auriferous Quartz; from the Findley Mine, Dahlonega.

Three specimens of Auriferous Pyrite and Limonite; from the Findley Mine, Dahlonega.

One specimen of Auriferous Quartz; from the Hedwig Mine, Lumpkin County.

Five specimens of Auriferous Quartz, Interlaminated with Hydromica-slate; from the Hedwig Mine, Lumpkin County.

MR. NICHOLSON, VISAGE, GA.

Three specimens of Gold in Quartz ; from the Magguire Vein, Dawson County.

Five specimens of Amethyst Crystals ; from Towns County.

THE TURKEY HILL GOLD MINING CO., AURARIA, GA.

Sixteen specimens of Free Gold in Quartz ; from the Turkey Hill Mine, Lumpkin County.

CAPT. J. W. WEAVER, DAHLONEGA, GA.

Four specimens of Free Gold in Quartz ; from the Singleton Mine, Dahlonega.

CAPT. J. A. COTTEN, THOMASTON, GA.

One specimen of Pyrite with Druzy Quartz in Agate ; from near Thomaston, Upson County.

Thirty-two specimens of Druzy Quartz on Agate ; from Wilmot's Ravine, near Thomaston, Upson County.

Two specimens of Chalcedony ; from Wilmot's Ravine, near Thomaston Upson County.

Fifty specimens of Water-bearing Quartz Pseudomorphs ; from Wilmot's Ravine, near Thomaston, Upson County.

One specimen of Staurolite Crystals ; from Upson County.

One specimen of Selenite Crystals on Chalcedony ; from Wilmot's Ravine, near Thomaston, Upson County.

MESSRS. SINGLETON & LARIMORE, ROCKMART, GA.

Six specimens of Pyrite Crystals in Talc ; from Paulding County.

Three specimens of Pyrite ; from Paulding County.

MR. E. J. ALHED, MINERAL SPRINGS, GA.

Three specimens of Pyrite and Quartz in Hydromica-slate ; from Pickens County.

One specimen of Pyrite ; from Pickens County.

Four specimens of Pyrite in Quartz ; from Pickens County.

MR. W. K. PHILLIPS, CARROLLTON, GA.

Four specimens of Pyrite in Quartz ; from Carroll County.

Four specimens of Flexible Sand-stone ; from Carroll County.

Two specimens of Sand-stone Showing Exterior Weathering ; from Carroll County.

GEN. J. H. PORTER, THOMSON, GA.

One specimen of Auriferous Pyrite in Quartz ; from McDuffie County.

One specimen of Auriferous Quartz ; from the Egypt Mine, McDuffie County.

MR. GEORGE W. ADAIR, ATLANTA, GA.

One specimen of Indian Axe ; from Fulton County.

Three specimens of Rock Crystal ; from the Vicinity of Atlanta.

HON. H. WARNER HILL, GREENVILLE, GA.

Three specimens of Quartz Crystals ; from the Vicinity of Greenville, Meriwether County.

MRS. M. K. JOHNSON, THOMASTON, GA.

One specimen of Quartz Crystals ; from near Thomaston, Upson County.

MR. W. C. TILTON, SPRING PLACE, GA.

Four specimens of Tripolite ; from Murray County.

One specimen of Talc ; from Murray County.

CAPT. W. R. McCONNELL, HIAWASSEE, GA.

Four specimens of Corundum ; from near Hiawassee, Towns County.

One specimen of Corundum with Zoisite and Chlorite in Chrysolite ; from Towns County.

MR. E. M. Y. ALGOOD, DALLAS, GA.

Three specimens of Corundum Coated by Margarite ; from Paulding County.

One specimen of Corundum ; from Paulding County.

One specimen of Soft Corundum ; from Paulding County.

MR. A. E. HEIGHWAY, MURPHY, N. C.

One specimen of Staurolite Twin Crystals ; from Towns County.

One specimen of Staurolite ; from Fannin County.

Three specimens of Staurolite Twin Crystals ; from Fannin County.

MR. H. A. LYONS, BATESVILLE, GA.

Two specimens of Corundum Crystals ; from Habersham County.

MR. W. T. PRATHER, ACWORTH, GA.

Two specimens of Soft Corundum ; from Paulding County.

MR. R. J. COOK, IVY LOG, Ga.

One specimen of Corundum Coated by Margarite ; from the Track Rock Mine, Union County.

MR. W. R. CRANDALL, DAHLONEGA, GA.

One specimen of Micaceous Hematite with Quartz ; from Lumpkin County.

MR. G. B. GRANT, CHALYBEATE SPRINGS, GA.

- One specimen of Magnetite ; from Talbot County.
- Two specimens of Limonite (very large); from Grant's Farm, near Chalybeate Springs.

THE ETOWAH IRON COMPANY, CARTERSVILLE, GA.

- Three specimens of Micaceous Hematite ; from Bartow County.
- Two specimens of Pyrolusite ; from Bartow County.
- One specimen of Psilomelane ; from Bartow County.
- Two specimens of Stalactitic Limonite ; from Bartow County.
- One specimen of Manganese Ore (large) ; from Bartow County.
- Four specimens of Limonite ; from Bartow County.
- Ten specimens of Manganese Ore ; from Bartow County.

MR. W. M. SCOTT, HIAWASSEE, GA.

- Three specimens of Chromite ; from Towns County.

MESSRS. GEORGE W. SATTERFIELD & SONS, CARTERSVILLE, GA.

- Two specimens of Pyrolusite ; from Bartow County.
- Five specimens of Manganese Ore ; from Bartow County.

MR. GEORGE H. CLARK, CEDARTOWN, GA.

- One specimen of Pyrolusite ; from Polk County.
- Seven specimens of Iridescent Limonite ; from Polk County.
- One specimen of Botryoidal Limonite ; from Polk County.
- One specimen of Stalactitic Limonite ; from Polk County.

MR. A. ARMSTRONG, MARIETTA, GA.

- One specimen of Iridescent Limonite ; from Polk County.
- Five specimens of Almandite Crystals ; from Cobb County.

MR. E. W. CLEMENTS, THROUGH GOV. W. Y. ATKINSON, ATLANTA, GA.

- Three specimens of Iridescent Limonite ; from Polk County.
- Two specimens of Stalactitic Limonite ; from Polk County.

THE ESTATE MINING & MANUFACTURING CO., ETNA, GA.

- Two specimens of Limonite ; from Bartow County.

THE TALLAPOOSA ORE CO., TALLAPOOSA, GA.

- Three specimens of Limonite ; from Bartow County.

THE GEORGIA MINING, MANUFACTURING & INVESTMENT CO., ATLANTA, GA.

- Eighteen specimens of Limonite ; from Bartow County.
- One specimen of Graphite ; from Bartow County.

MR. C. M. JONES, EMERSON, GA.

One specimen of Limonite ; from Bartow County.

MR. J. D. TAYLOR, SUMMERVILLE, GA.

Twenty-two specimens of Bauxite ; from Chattooga County.

Twenty-five specimens of Bauxite ; from Walker County.

Two specimens of Pyrite Formed in Lignite ; from near Summerville, Chattooga County.

One specimen of Melanterite on Lignitic Pyrite ; from near Summerville, Chattooga County.

Eight specimens of Lignite ; from near Summerville, Chattooga County.

Three specimens of Melanterite on Bauxite ; from near Summerville, Chattooga County.

Two specimens of Hematite ; from near Summerville, Chattooga County.

CAPT. J. O. ROBERTSON, CANTON, GA.

One specimen of Yellow Ochre ; from Cherokee County.

THE REPUBLIC MINING & MANUFACTURING CO., HERMITAGE, GA.

Seven specimens of Bauxite ; from Hermitage Mine, Floyd County.

Seven specimens of Bauxite ; from Floyd County.

One specimen of Kaolin ; from Floyd County.

MR. J. W. BRODERICK, DALTON, GA.

Four specimens of Marble ; from Whitfield County.

MR. J. H. HOGUE, ROCKMART, GA.

Three specimens of Marble ; from Polk County.

MR. JOHN NICHOLS, YOUNG HARRIS, GA.

One specimen of Green Oligoclase in Granite ; from Towns County.

MR. W. T. WALKER, CARROLLTON, GA.

One specimen of Anthophyllite with Chlorite ; from Carroll County.

AMERICAN GEMS COMPANY, ATLANTA, GA.

One specimen of Almandite Crystal (sawed) ; from Campbell County.

MESSRS. S. W. GOODE & Co., ATLANTA, GA.

One specimen of Muscovite ; from Rabun County.

MR. R. C. SHARP.

One specimen of Muscovite ; from Pickens County.

MESSRS. J. R. VANBUREN & CO., GRISWOLDVILLE, GA.

Thirty-seven specimens of Pottery Clay ; from Jones County.

MR. A. J. JENNINGS, BROOKLYN, N. Y.

One specimen of Monazite Sand ; from The Glades, Hall County.

MR. J. M. STATE, BLUE RIDGE, GA.

One specimen of Indian Axe ; from Fannin County.

One specimen of Indian Skin-scraper ; from Fannin County.

One specimen of Indian Implement ; from Fannin County.

MR. LOGAN BLECKLEY, ATLANTA, GA.

One specimen of Indian Pipe ; from Habersham County.

THE GRAYSVILLE LIME CO., GRAYSVILLE, GA.

Two jars of Lime ; from Catoosa County.

OSCEOLA MINING CO., NEW ORLEANS, LA.

One specimen of Auriferous Quartz ; from Cherokee County.

MR. JOHN CROSS, ATLANTA, GA.

One specimen of Auriferous Quartz ; from the Wilkes Mine, Meriwether County.

Three specimens of Native Gold in Quartz ; from Meriwether County.

THE VILLA RICA MINING & MILLING CO., VILLA RICA, GA.

One specimen of Auriferous Quartz ; from Carroll County.

THE ROME IRON COMPANY, ROME, GA.

Sixteen specimens of Limonite ; from the Etna Mine, Polk County.

THE MARSH IRON CO., PRIORS, GA.

One specimen of Limonite ; from Priors, Polk County.

MESSRS. T. F. BURBANK & CO., CEDARTOWN, GA.

One specimen of Limonite ; from the Wray Mine, Polk County.

THE COLUMBIA MINING CO., THOMSON, GA.

One specimen of Auriferous Quartz ; from the Columbia Mine, McDuffie County.

MAJOR SINGLETON, ROCKMART, GA.

Two specimens of Manganese Ore ; from Paulding County.

Four specimens of Magnetite ; from Paulding County.

MR. JOSEPHUS ROBERTS, PHILADELPHIA, PENN.

Eight specimens of Auriferous Pyrite in Quartz ; from the Currahee Mine, Hall County.

MR. J. D. KEMP, ACWORTH, GA.

Six specimens of Auriferous Quartz in Mica-schist ; from Cobb County.

THE SOUTHERN EXPLORATION & FINANCIAL CO., LONDON, ENG.

One specimen of Auriferous Quartz ; from Douglas County.

MESSRS. ATKINSON & DUNWOODY, VILLA RICA, GA.

One specimen of Auriferous Pyrite in Quartz ; from Douglas County.

THE GARNET GOLD MINING & WATER CO., NEW YORK CITY.

Sixty specimens of Auriferous Quartz ; from the Garnet Gold Mine, Lumpkin County.

Two specimens of Auriferous Decomposed Hydromica-slate ; from Shaft No. 4, Garnet Mine, Lumpkin County.

THE CHESTATEE PYRITES CO., ATLANTA, GA.

One specimen, consisting of large lumps of Pyrite ; from the Chestatee Pyrites Mine, Lumpkin County.

THE SOUTHERN BROWN-STONE CO., CHATTANOOGA, TENN.

One large dressed block of Red Sandstone ; from near Graysville, Catoosa County.

THE GEORGIA MARBLE CO., TATE, GA.

Ten dressed 8-in. cubes of "Creole," "Etowah," "Kennesaw," and "Cherokee" Marbles ; from the Georgia Marble Co.'s Quarries in Pickens County.

Six polished 4 x 6-ft. slabs of the same Marbles.

THE SOUTHERN MARBLE CO., ATLANTA, GA.

Three dressed 8-in. cubes of White Marble ; from the Southern Marble Quarries, Marble Hill, Pickens County.

MR. FRANK W. HALL, DAHLONEGA, Ga.

Two large specimens of Gold Ore ; from the Lockhart Mine, Dahlonega, Lumpkin County.

THE CHATTAHOOCHEE LAND CO., ATLANTA, GA.

One specimen of Iron Ore, consisting of Large Lumps of Limonite ; from Cherokee County.

MR. C. E. BUEK, RICHMOND, VA.

Two large specimens of Hematite ; from the Bronco Mine, Walker County.

THE CHICKAMAUGA COAL & IRON CO., CHICKAMAUGA, GA.

One large Column of Bituminous Coal ; from Walker County.

MESSRS. DICKERSON & CAMERON.

Eight specimens of Auriferous Pyrite in Quartz ; from the Franklin Gold Mine, Cherokee County.

THE CEDARTOWN LAND CO., CEDARTOWN, GA.

Twenty specimens of Limonite ; from Clarke & Miller's Mine, Polk County.

MR. G. W. LINDSEY.

Six specimens of Limonite ; from Polk County.

MESSRS. WATERMAN BROS.

Four specimens of Auriferous Quartz ; from the Cox Mine, Cherokee County.

MCGARRITY & WYATT.

Five specimens of Pyrite in Hydromica-slate ; from Paulding County.

Three specimens of Auriferous Decomposed Pyrite in Mica-slate ; from the Wyatt Mine, Paulding County.

RECEIVED AS LOANS

MR. R. K. REAVES, ATHENS, GA.

Four Gold Nuggets, varying from 10 to 83 dwts. ; from the Loud Mine, White County.

Ninety-seven specimens of Free Gold in Quartz ; from the Loud Mine, White County.

CAPT. J. W. WEAVER, DAHLONEGA, GA.

Two specimens of Free Gold in Galena and Quartz ; from the Battle Branch Mine, Lumpkin County.

One pair of Gold-in-Quartz Cuff-buttons ; from the Singleton Mine, Dahlonega.

MR. JOHN MARTIN, CLEVELAND, GA.

Seventy-five Gold Nuggets (29 oz.), varying from 2 to 60 dwts. ; from the Hamby Mountain Mine, White County.

Two gold Sponge Residues from Amalgam (33 oz.); from the Hamby Mountain Mine, White County.

MRS. J. BELKNAP SMITH, THOMSON, GA.

One Specimen of Gold in Quartz ; from William Boyd's Property, Lincoln County.

MRS. W. A. CHARTERS, DAHLONEGA, GA.

One Gold Nugget ($34\frac{1}{4}$ dwts.); from the Richardson Placer Mine, White County.

THE HAND & BARLOW UNITED GOLD MINING & HYDRAULIC WORKS CO., DAHLONEGA, GA.

Several Gold Panning Results ; from the Barlow and other mines, Lumpkin County.

MR. J. C. WILLIAMS, THOMASTON, GA.

One specimen of Quartz Crystal Showing Secondary Growth ; from Upson County.

One specimen of Smoky Quartz Crystals ; from Upson County.

One specimen of Corundum Crystals ; from Upson County.

MR. A. E. HEIGHWAY, MURPHY, N. C.

Five specimens of Corundum ; from Towns County.

One specimen of Corundum in Margarite ; from Towns County.

One specimen of Corundum Coated by Damourite ; from Towns County.

One specimen of Corundum Crystals ; from Union County.

MR. T. S. BEAN, CLARKESVILLE, GA.

Five specimens of Ruby Corundum ; From Habersham County.

One specimen of Rutile Crystal ; from Graves Mountain, Lincoln County.

PROF. W. O. CONNOR, CAVE SPRING, GA.

Four specimens of Pyrolusite; from Cave Spring, Floyd County.

Five specimens of Limonite; from Floyd County.

One specimen of Botryoidal Limonite; from Polk County.

One specimen of Gypsum in Limonite; from Polk County.

MR. W. T. THOMAS, BLUE RIDGE, GA.

One specimen of Indian Mortar; from Fannin County.

PROF. L. P. SMITH, LAGRANGE, GA.

A Collection of Amethyst, Quartz, Tourmaline, Indian Relics etc., from various parts of the State.

MR. JOHN R. GLEN, CLEVELAND, GA.

Two hundred and three specimens of Indian Relics; from White County.

AWARDS

It gives me pleasure to state, that the highest award made by the Exposition Company, a gold medal and a diploma, was conferred upon the Geological Survey of Georgia, for its exhibits of Minerals, Ores and Building-stones; and the same award was made to it, for its Forestry exhibit. A special diploma was also awarded to my assistant, Dr. John K. Small, for the intelligent manner, in which he collected and prepared the excellent exhibit of Georgia woods.

The exhibits of minerals, ores, building-stones and woods attracted a great deal of attention at the Exposition. It was unfortunate, that the basement floor of the Georgia State building had to be assigned to these exhibits; for hardly twenty per cent., of the visitors to this building, discovered the hall, in which these exhibits were made. Yet, the comments of those, who did see them, were of the most gratifying nature. No exhibits of minerals, ores, building-stones or forestry specimens, brought forth more favorable comment from those, who saw them. Georgia stood at the head.

WORK OF THE PREPARATOR AND THE CHEMIST

Mr. Moore, as Preparator, began the work of unpacking, classifying, cataloguing, numbering and labelling the material, collected by my predecessor and his Assistants, and by myself and my Assistants, in the course of the regular field-work of the Survey; and, as material came in from the field, from those of us, who were collecting the minerals, ores and building-stones for display at the Exposition, this was put through the same routine, trimming and cleaning the specimens, to improve their appearance. In the matter of identifying, classifying, selecting and rejecting material, every specimen passed under my own hand. As the time drew near for the opening of the Exposition, the minerals, in the "Display Room" of the Department of Agriculture, were turned over to me by the Commissioner; and these went through the same process of preparation. Later on, Mr. Moore was engaged in packing the prepared exhibits in the mineral laboratory at the capitol, and unpacking them at the Exposition.

The Chemist, who was employed for a brief period only, made analyses of minerals and ores coming in from the field.

THE STATE MUSEUM

By the Act of the Legislature, reviving the office of State Geologist, to that officer was entrusted the work of collecting, analyzing and classifying specimens of minerals, plants and soils, and causing "to be preserved, in a museum, specimens illustrating the geology,

PLATE IV.



EXHIBIT OF GEORGIA WOODS, IN THE STATE MUSEUM.

mineralogy, soils, plants, valuable woods, and whatever else might be discovered in Georgia of scientific or economic value." Systematic effort, in this direction, however, had never been begun, until the opportunity offered, last year, by the collection of material, for the State's exhibit at the Exposition. The material thus collected, augmented by that, which had been collected by the geologists, as illustrating their work, and by the material, formerly exhibited in the Display Room of the Department of Agriculture, would certainly form an excellent nucleus for a State Museum. Acting in accordance with this suggestion, the State Exhibit Commission and the Commissioner of Agriculture, at the close of the Exposition, turned over to me all the material of a permanent character, in their custody. This I have installed in the corridors of the third floor of the capitol, which were assigned, by Your Excellency, for use as temporary quarters, until a permanent Museum building shall be provided.

The Exhibit, as at present installed, consists of —

1st. A SYSTEMATIC SERIES OF MINERALS, numbering 930 specimens, displayed in the six slope-top plate-glass cases, used at the Exposition.

2nd. A SYSTEMATIC SERIES OF ORES, CLAYS, ABRASIVES ETC., numbering 149 specimens, temporarily displayed on five of the tables used at the Exposition.

3rd. An oblong stepped pyramid, on which is arranged 50 CUBES OF BUILDING-STONES, consisting of marble, granite, gneiss, hornblendite, sandstone, serpentine and "caen-stone," from various localities in the State. This display of building-stones is not equalled by that of any other State in the Union; and, while it does not number so many specimens, yet in size of specimens and in attractiveness, it is not equalled by the National Collection.

4th. A SERIES OF SIX SLABS OF MARBLE, white, mottled, pink and gray, from the quarries of the GEORGIA MARBLE COMPANY, at Tate, displayed on the walls of the Museum, as panels, with gold-and-black framed labels.

5th. A pyramid of large lumps of PYRITE from Lumpkin county ; a large specimen of BROWN SANDSTONE from Catoosa county ; and three large specimens of GOLD, IRON AND MANGANESE ores from various counties, displayed on some of the large wooden bases, that were used at the Exposition.

These are all in the corridors of the north end of the capitol. In those of the south end, is displayed the biological material of the Museum, consisting of the COLLECTIONS OF WOODS AND FRUITS OF GEORGIA, etc. The woods are displayed on two large polished Georgia-pine stepped bases, and two smaller ones of the same material, all designed to suit the peculiar architectural conditions of the corridor. In double-rows, one above the other, 147 specimens of classified woods, all cut as before described, are arranged. On four of the special tables, used at the Exposition for the display of ores, is temporarily installed the fruit exhibit, contained in 236 bottles, varying in capacity from one pint to fifteen gallons. An imperfect series of cotton, from the plant to the spindle, is on exhibition. This will be renewed, and put in good shape, at the first opportunity. A few specimens, illustrating animal life, have been installed ; but this department of the Museum can scarcely be said to have, as yet, a beginning. All the specimens of ores, minerals and building-stones have been catalogued, the number of specimens catalogued being 3,352, and the number of the last entry in the catalogue 1,470. In a short time, the specimens in all the departments will be catalogued, and the catalogue-number painted, in durable, but inconspicuous, figures, on each specimen, as has been done in the case of the minerals, ores and building-stones. This is absolutely necessary, in order to preserve the history of each specimen, without which it has little value.

No State in the Union has greater possibilities, for the building up of a great museum, than Georgia. Apart from an exhibition of its mineral, forestry and fruit products, abundant material exists in

its animal and bird life, its fishery resources, its general agricultural and horticultural products, and its extensive manufacturing interests. In the past, Georgia has had a proud part in the defense of our common country, and in the building up of the nation; and there have been many relics, silent witnesses to the noble sacrifice of life and means, of Georgia's best citizens. For want of proper care, many of these have been lost, while a few are yet in existence, in the hands of private parties, scattered throughout the State. An important department of the State Museum should be the Department of Historic Relics, where persons, owning these sacred evidences of past history, might deposit them, or give them to the State, to be exhibited and seen by thousands of visitors, every year, being assured, that all such material would be carefully preserved, in the State Museum, and would be properly labelled, and displayed in an attractive manner. Unless some public care is given to the preservation of these relics, the time will come, when the most of them will be lost, as families die out, and their personal effects go into the hands of others. The Georgia State Museum should be an epitome of Georgia—her resources, her industries and her history. It shall be my constant aim, to make such additions to the collections, and to build up such additional departments, to the nucleus already established, as may be necessary, to make the Museum both an exposition of the State's resources and industries, and a place to be sought for its educational value.

I have recently appointed Mr. S. W. McCallie, Assistant Geologist, to be Assistant Curator of the Museum, in immediate charge of the biological departments, under my direction. It will be necessary to employ two watchmen and a laborer, to protect the Museum from depredators, and to keep it in clean condition. To this, further mention is made, under another division of this report.

ACKNOWLEDGEMENTS¹

In addition to the gifts to the State Museum, already acknowledged, under the proper head, in the part of this report, which refers to the State Exhibit, Cotton States and International Exposition, the following gifts and deposits have been received and catalogued, since the close of the Exposition: —

RECEIVED AS GIFTS

MR. JOHN CROSS, ATLANTA, GA.

One specimen of Free Gold in Quartz; from 4 miles Southwest of Grantville, Meriwether County.

MR. E. S. RILEY, ATLANTA, GA.

One specimen of Native Sulphur in Quartz, Resulting from the Alteration of Pyrite Crystals; from Vining Mountain, Haralson County.

MR. GEORGE R. CHUPP, DECATUR, GA.

One specimen of Rhodonite; from DeKalb County.

MR. JAS. W. MADDOX, WHITE HOUSE, GA.

One specimen of Tourmaline Crystal; from Henry County.
Six specimens of Massive Quartz; from Henry County.

MR. JOHN PITTS, McCULLOM, GA.

One specimen of Tourmaline in Quartz; from Coweta County.

PROF. L. P. SMITH, LAGRANGE, GA.

One specimen of Asbestos; from Troup County.
One specimen of Quartz Crystals; from Troup County.

¹ Only such specimens, as have been catalogued, are here acknowledged. Others, received late in the year, will be acknowledged, in the report for 1896-97.

MR. R. K. REAVES, ATHENS, GA.

One specimen of Gold Crystals on Quartz; from the Loud Mine, White County.

MR. R. R. SIBLEY, ATLANTA, GA.

One specimen of Indian Tomahawk; from Atlanta.

SOUTHERN MARBLE COMPANY, ATLANTA, GA.

Its Exposition Exhibit of White Marble, consisting of —

One large dressed Block, 22 ft. 6 in. by 4 ft. 4 in. by 2 ft. 6 in.,
(weight, 45,000 lbs.)

One dressed Plinth, about 10 ft. by 2 ft. by 2 ft.

One dressed Plinth, about 8 ft. by 2 ft. by 2 ft.

One dressed Plinth, about 3 ft. by 2 ft. by 1 ft. 6 in.

One polished Sphere, 3 ft. 11 1/2 in. in diameter.

RECEIVED AS DEPOSITS

MR. R. R. SIBLEY, ATLANTA, GA.

One specimen of Almandite Crystals; from Atlanta.

MR. JOHN MARTIN, CLEVELAND, GA.

Fourteen Gold Nuggets (15 1/2 oz.); from the Hamby Mountain Mine, White County.

MRS. W. A. CHARTERS, DAHLONEGA, GA.

One Gold Nugget (34 1/4 dwts.); from the Richardson Placer Mine, White County.

MRS. J. BELKNAP SMITH, THOMSON, GA.

One specimen of Gold in Quartz; from William Boyd's Property, Lincoln County.

PROF. W. O. CONNOR, CAVE SPRING, GA.

Four specimens of Pyrolusite; from Cave Spring, Floyd County.

Five specimens of Limonite; from Floyd County.

One specimen of Botryoidal Limonite; from Polk County.

One specimen of Gypsum in Limonite; from Polk County.

MR. W. T. THOMAS, BLUE RIDGE, GA.

One Indian Mortar ; from Fannin County.

MR. T. S. BEAN, CLARKESVILLE, GA.

Five specimens of Ruby Corundum ; from Habersham County.

One specimen of Rutile Crystal ; from Graves Mountain, Lincoln County.

MR. J. C. WILLIAMS, THOMASTON, GA.

One specimen of Quartz Crystal Showing Secondary Growth ; from Upson County.

One specimen of Smoky Quartz Crystals ; from Upson County.

One specimen of Corundum Crystals ; from Upson County.

CAPT. J. W. WEAVER, DAHLONEGA, GA.

Two specimens of Free Gold in Galena and Quartz ; from the Battle Branch Mine, Lumpkin County.

A MUSEUM BUILDING

While the corridors, now in use as a museum, are well lighted through the skylight ; still, in other particulars, they are very poorly adapted to such use. A museum should occupy the ground-floor of a building, especially designed for that purpose ; both in order that it may be easy of access, insuring the maximum number of visitors, and in order that massive and imposing specimens may be displayed ; for such specimens often determine the lasting impressions, made by such a display. A museum should be well lighted, not only by skylights, but also by side-lights. Specimens on exhibition must be seen to the best advantage, to be fully appreciated ; and abundant, well-diffused light is, here, an absolute necessity. The halls of such a building must be broad, to admit of striking effects, ease in serial arrangement and wide central aisles ; and graceful columns and high screens should be the only partitions between the large halls, thus

permitting the continued growth of the collections. In no case, should the collections in a museum have a large intervening space between them, as in our Museum, as at present installed, where the material in the south corridors is so widely separated from that in the north corridors, by the large rotunda and the long dark halls, leading from the north to the south corridors. All necessary offices, laboratories, storage-rooms etc. should find accommodation in an up-to-date museum-building.

Georgia should have a State Museum building, of liberal proportions, located in the immediate vicinity of the capitol. It should be built of Georgia granite or the beautiful brown sandstone of Catoosa county; and its interior decorations should be of Georgia marbles and polished Georgia woods. It has often been urged against Georgia building-stones, when in competition with those from other States, that Georgia had to go outside her territory for the stone, with which to build her capitol; and failure to use, for this purpose, the very superior stones, quarried in Georgia, has, doubtless, turned hundreds of thousands of dollars to other States. A notable instance, in my own experience, was the case of the Kansas City Government-building, now in process of erection. When I appeared before the Board of Award, appointed by Secretary Carlisle, to select the stone for this elegant building, the first question, put to me was: — “If you have such fine building-stones in Georgia, why was it necessary to go outside the State, to get stone to build her capitol”? This was explained by the conditions of the industry then existing, etc.; but Secretary Carlisle set aside the award of the Board to the Stone Mountain granite, and directed, that the structure be built of the Texas granite, from which the capitol of Texas had been built. A magnificent State Museum, built of Georgia stones and woods, would be a most valuable refutation of such unjust disparagements.

Already the State capitol has begun to be crowded for space, with the increasing demands of the State, in its onward march, in the line

of civilization, towards greater prosperity; and a Museum building should provide offices, laboratories and storage-rooms for the Geological Survey, and for the chemical laboratory of the Agricultural Department, if the Commissioner of Agriculture should think it desirable.

FIELD-WORK

Notwithstanding that it was necessary to give a great deal of attention to the Exposition work, last year, the field-work has not, to a great extent, been retarded. Mr. McCallie, continuing the survey of the Phosphates, in the southern part of the State, found it desirable to include with it the work on the Marls, and to publish a report on the two, combined, the relations, the one to the other, being so close. He has finished work on these subjects in Decatur, Thomas, Brooks, Lowndes, Echols, Clinch, Charlton, Camden, Glynn, McIntosh and Liberty counties. A bulletin on "THE PHOSPHATES AND MARLS" of these counties is now in press; and it will be issued, in due course of time, as the first of a series on this subject. He has also made examination of the Artesian Wells in the above counties, the results of which will be published in a bulletin on the ARTESIAN WELL SYSTEM of the State. Messrs. King, McCallie and myself have continued work on the GOLD DEPOSITS of the State; and a bulletin on this subject is now in press. It will be issued, in the course of a short time, as sub-bulletin No. 1; of this series.

The gold deposits of nineteen counties have been surveyed, as follows: — Rabun, White, Dawson, Hall, Gwinnett, Forsyth, Milton, Fulton, Towns, Union, Fannin, Gilmer, Cherokee, Bartow, Paulding, Haralson, Carroll, Habersham and Lumpkin. These will be included in the bulletin above mentioned.

The latter part of last March, Dr. Ladd, by my instruction, began the work of making a survey of the CLAYS OF GEORGIA, in the southern part of the State. He made a preliminary canoe-trip down the Chattahoochee river, and one down the Ocmulgee and Altamaha rivers, with the view of making, so far as was possible, a geological section, with special reference to the clay formations in southwest Georgia. Since then, he has taken up, systematically, the work in the counties of Bibb, Jones, Baldwin, Wilkinson and Twiggs; and the results of these surveys will be published, soon, in a bulletin, now in press, the first of a series, which I propose to issue on this important subject. Quoting from Dr. Ladd's special report to me: — "The results attained in this region were surprisingly good, a vast amount of clay having been discovered, suitable for the manufacture of any product, which clay is used for." It may not be amiss to say, that more inquiries, as to the clays of the State, have been received by me, from parties living outside the State, than on any other economic subject, except gold; and in nearly all cases, the inquiries have come from consumers, seeking raw material.

In order to ascertain whether or not the drainage of the swamps of southwest Georgia would be possible, I employed, by advice of the Geological Board, a topographic party, with Mr. D. Lee Wardroper in charge, to proceed to Calhoun and the neighboring counties, and to make a topographic survey of as much of the territory as possible, in the limited time our funds would permit. The Chickasawhatchie creek, with its water-basin, was selected as the base of operations; and a period of nearly three months was devoted to field-work, 130 square miles of territory and 216 linear miles of traverse control lines having been surveyed, comprising parts of Calhoun, Dougherty and Baker counties. Mr. Wardroper has submitted a short report, with an excellent topographic map of the section surveyed, as the result of his short field-season, showing, that the drainage of the swamps is feasible, and that it can be accomplished, within the limits of

reasonable expense. In any future topographic work, in completing the map of the State, it will not be necessary to re-survey this area. The map, which is on a scale of $\frac{1}{2}$ mile to the inch, with contour intervals of 10 feet, is on file, with this report, in my office, where they may be seen by anyone interested.

REPORTS

In addition to the bulletins, mentioned above, there is, now, in press, nearly ready for issue, the report on the "WATER POWERS OF GEORGIA", compiled by Mr. B. M. Hall, Special Assistant, from the field-notes of Mr. C. C. Anderson, Assistant Geologist under the administration of my predecessor. Bulletin No. 2, on the "CORUNDUM DEPOSITS OF GEORGIA", which was in press, at the time of my last report, was issued, early in 1895. By a peculiar mishap, the arrangement with Dr. Hayes, Assistant Geologist, U. S. Geological Survey, for a report on the Aluminum deposits, fell through; and the material, which was intended for publication, as a bulletin of this Survey, was published in "MINERAL RESOURCES OF THE UNITED STATES FOR 1894-1895", by the U. S. Geological Survey. The Geological Survey of Georgia was in no way responsible, for the failure to publish this report, as one of its bulletins. Later on, when further information shall demand it, it is my intention to have made, by one of our officers, a detailed survey of these deposits, which will be published in bulletin form.

MISCELLANEOUS WORK

During the period, since my last report, a great many specimens have been sent to me, by people living in various parts of the State, with the request, that I identify them, and report as to their character. Of such material, I have reported on 641 specimens of minerals, ores and rocks, since my last report. For lack of time, considerable material of this kind has not, as yet, been examined. Due attention will be given to it, however, as soon as possible.

In the latter part of January, 1895, it became known to the Geological Board, and to myself, that a large contract was to be awarded, for the superstructure of the Government Building at Kansas City, Mo.; and that Messrs. Manning and Parsons of Washington, D. C., had submitted the lowest bid for the stone to be used in this structure, their bid specifying Stone Mountain (Georgia) granite. We also learned, that an effort was being made, by persons interested, to have this bid set aside; and that much unjust criticism was being made, abusive of the character and quality of this stone; also, that it was likely, that on this account, the Board of Award, selected by the Secretary of the Treasury, would reject this granite. In order that this important industry of our State should not be unjustly dealt with, in a contract of such magnitude, I made a personal investigation of the character of this stone; and, after being thoroughly satisfied, that the criticisms were unfair, and were being used by malicious persons, to further their own ends, by advice of members of the Advisory Board of the Geological Survey, I went to Washington City, and made an argument before the Board of Award, favorable to the character of the Stone Mountain granite as a building-stone; and I proved, conclusively, to this Board, that the charges

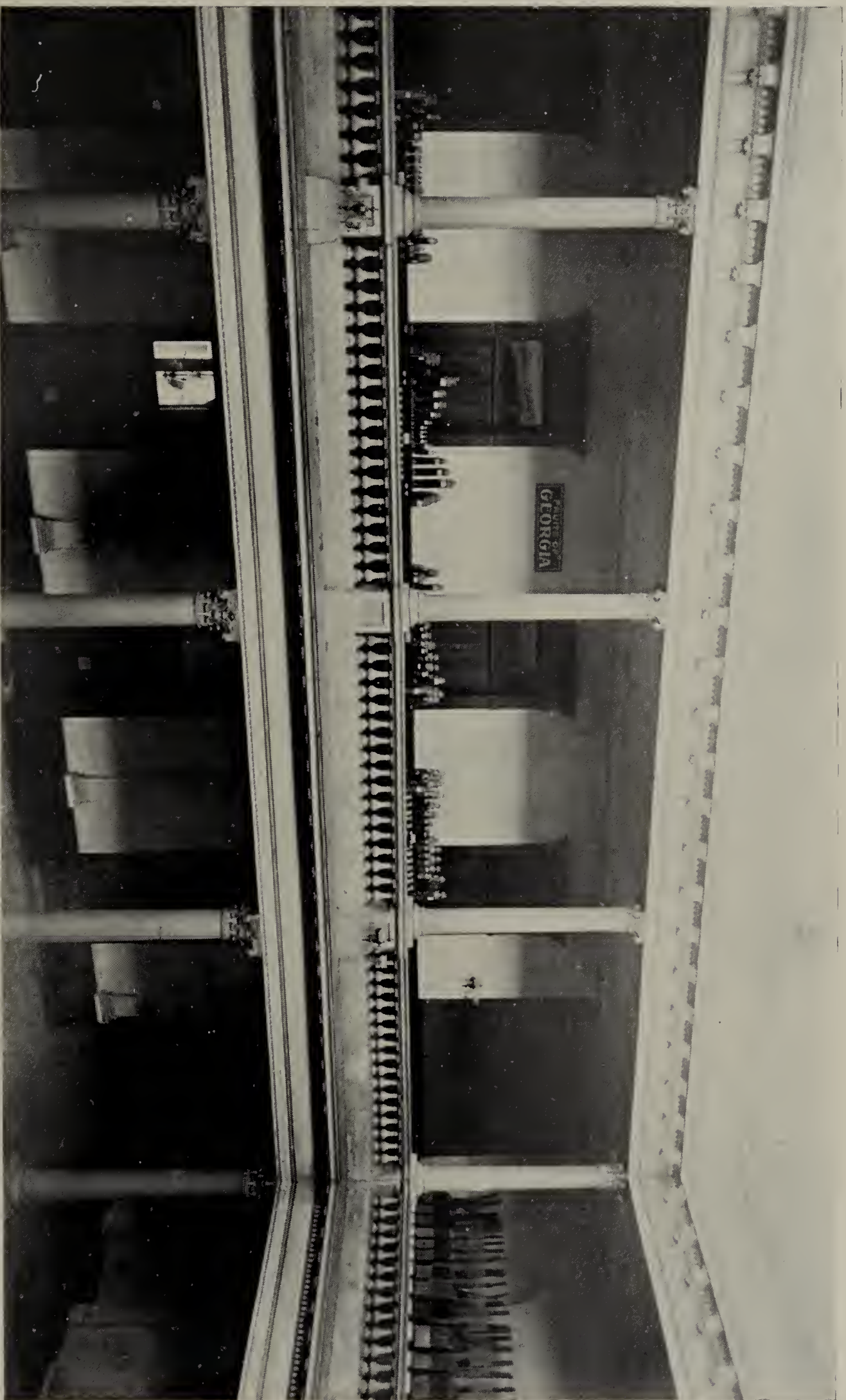
were untrue, and that the stone was of excellent quality, and in every way, suitable for such a structure; so, that the Board of Award, on the afternoon of the day, in which I appeared before them, awarded the contract to Messrs. Manning and Parsons, the Stone Mountain granite to be used in the structure. This contract, amounting to \$297,500, would have been of great benefit to the State, if the award had not been set aside, by the Secretary of the Treasury, for reasons, in which the quality and quantity of the stone played no part.

SOME RESULTS

I take a pardonable pride in some of the results, already attained by the Geological Survey, during my administration, notwithstanding the lamentable financial depression, which has existed all over the country, for the past four years, to a large extent deterring investors, from taking advantage of the information, set forth in the two economic bulletins, which we have already issued.

In my last Administrative Report, I called attention to the magnificent building, St. Johns Hospital in New York City, which was built of the beautiful white marble from the Piedmont Marble Quarries in Pickens county, as the direct result of an official report by me, thus bringing into the State an investment of \$240,000, and giving the Piedmont Marble Co. the means of fitting up the most complete quarrying-plant in the South. More recent evidence of the value of our work is found in the large new Corcoran Art Gallery in Washington City, and the elegant new State House of Rhode Island, both of which are now being constructed of marble from the quarries of the Southern Marble Company at Marble Hill, Pickens county. I have furnished as many copies of Bulletin No. 1,

PLATE V.



DISPLAY OF GEORGIA FRUITS, IN THE STATE MUSEUM.

on "The Marbles of Georgia," to this and other marble companies in the State, as they have been able to distribute among the architects and builders of our northern cities; and, strengthened by this official report, the two large contracts mentioned above, and others of minor consideration, have been effected. This is but the beginning of the good, that this one bulletin may accomplish.

On account of the shutting down, during the past two years, of so many factories and mills, consumers of corundum, no advance has been made in the mining of this valuable mineral, of late; and the practical results of our economic bulletin, on the "Corundum Deposits of Georgia," must be seen, in the future development of these important deposits.

It is with some degree of pleasure, that, having so radically departed from the former plan of a geological survey, by laying special emphasis on the economic resources of the State, and giving attention to them, first, I have received letters of congratulation from many of the leading geologists and other distinguished scientists of this country, and from practical business men, on the character of the two bulletins, which we have issued.

REQUIREMENTS OF THE SURVEY

The expenses of the Survey have been administered as economically, as it has been in my power to do. A great deal of good has already been accomplished; but much remains to be done. The appropriation of \$8,000 per annum, with only \$3,000 of it to pay the expenses of the Survey and the Museum, outside of the salaries of the three Geologists, is not adequate to do the work that ought to be done in Georgia. Few, if any, States, having a Geological Survey, appropriate so small an amount per annum, for this important work.

CHEMIST

There should be a Chemist, regularly employed by the year, as an officer of the Survey. In doing the work of economic geology, it is necessary to make large numbers of analyses and assays of minerals, ores, building-stones, soils, mineral-waters etc.; and a good chemist could be constantly and profitably occupied, by the work of the Survey. Such a chemist should receive a salary of not less than \$1,500.

FOR TOPOGRAPHY

I wish to call attention to the fact, that, before good geological work can be accomplished, the topography of the State must be mapped out. No appropriation has been made for topographic parties for the work of the Survey, though the law requires, that a topographic survey be made. The United States Geological Survey began, in this State, fifteen or twenty years ago, the work of making a topographic survey; and they have surveyed 13,000 square miles, up to the present time, maps of which have been published. Very little work of this kind has been done in this State, by the United States Geological Survey, during the last ten years; but, the Director is very anxious to co-operate with the State Survey, in doing this work; and he has made a proposition to me, that, for every \$1,000 put into this work by the State, another \$1,000 will be put in, by the United States Geological Survey, so that the work may be pushed rapidly, and the world the sooner have the benefit of the information. The Director of the United States Geological Survey expresses

the hope, that Georgia may devote not less than \$5,000 a year to this subject, for a definite period of years, which, with the \$5,000 contributed by the United States Geological Survey, will make \$10,000 a year, to be applied to the finishing of a topographic map of this State. I cannot too strongly commend this matter, as it is one of very great importance to the State's material development; and, it is to be hoped, that the Legislature will make suitable provision for carrying out this work.

PAY OF ASSISTANT GEOLOGISTS

A change should be made in the law, which fixes the salaries of the Assistant Geologists at a stated figure. The value of the services of men varies widely; and assistants should be employed, according to their special fitness and experience. The longer a man serves on the Survey, the more valuable should his services become; and the more hope held out to him for further promotion, the more is he encouraged to put forth his best efforts in his work. The amount, fixed by the statute, as the salary of the two Assistant Geologists, is not sufficient, to enable me to employ and retain first-class men, to do the work of the Survey. Young men, graduating from our institutions of higher education, receive from \$1,000 to \$1,200, before they have acquired more than a university training. Well-qualified men, who, in addition to this training, have had several years' experience in the work, should certainly command better salaries than these. It is customary to leave the employment of assistants on State Surveys and the rate of their compensation, to the discretion of the head of the Survey, as he can best judge of their worth; but, if, in the case of the Georgia Survey, the Legislature should not think it desirable, to leave the compen-

sation of the Assistants to the State Geologist, I would be pleased to have the matter left to the discretion of the Geological Board. I trust that such action will be taken, at this session of the Legislature, as will bring this about.

FOR THE MUSEUM

In collecting together material for a great museum, it is necessary to provide suitable cases for the exhibition of material, and for the storage of such, as has to be used for the study of the problems of economic geology, etc. In these collections, largely exists the permanent value of the work done by the Geological Survey. For the proper care and preservation of these collections, two watchmen and a laborer are required.

Two hundred and fifty dollars a month will not meet all these necessary expenses, in addition to the field and incidental expenses of the Survey.

FOR PRINTING REPORTS

In order to advertise the results of the work of the Survey, a sum of \$2,000 per annum should be appropriated for the printing of reports, and for maps and illustrations; to form a part of the General Printing Fund. It is necessary to print these reports in a neat and attractive way; and they should be supplied with all necessary maps, and a liberal number of good illustrations. The sum of \$1,000 per annum of the Printing Fund, designated by the Legislature, as the amount to be used in the publication of reports, has not proved sufficient to enable us to do this work, as it should be done.

ACKNOWLEDGMENT TO THE ADVISORY BOARD

In conclusion, I wish to acknowledge my thanks to the members of THE ADVISORY BOARD, for their kind co-operation and liberal assistance, in the conduct of the Survey. Our relations continue to be of the most cordial character ; and my efforts, to carry to successful issue the work entrusted to me, have been made the easier, because of their intelligent consideration of the needs of the work.

Very respectfully yours,

W. S. YEATES,

STATE GEOLOGIST.

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GEOLOGICAL SURVEY OF GEORGIA

W. S. YEATES, State Geologist

ADMINISTRATIVE REPORT

OF THE

STATE GEOLOGIST

For the Year Ending

October 15th, 1897

ATLANTA, GA.

GEO. W. HARRISON, State Printer
(Franklin Prtg. & Pub. Co.)

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THE ADVISORY BOARD
of the Geological Survey of Georgia

(Ex-Officio)

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GEORGIA STATE EXHIBIT OF MINERALS, ORES AND BUILDING MATERIALS



ING STONES, TENNESSEE CENTENNIAL EXPOSITION.

ADMINISTRATIVE REPORT

GEOLOGICAL SURVEY OF GEORGIA,
ATLANTA, October 16th, 1897.

*To His Excellency, W. Y. ATKINSON, Governor, and President of the
Advisory Board of the Geological Survey of Georgia,*

SIR: — I have the honor to submit my administrative report, for the year ending October 15th, 1897.

Each year, the administrative work of my office has increased, and the year just closed has been no exception to this rule. Many inquiries, as to the various mineral resources of the State continue to come in, from outside the State; and our own people have sought largely information from the Geological Survey, as to the minerals and ores occurring on their own properties. As much attention as possible has been given to these personal wants; but, since the law requires, that the Survey shall be made, systematically, after a settled plan, it is not at all improbable, that there may be some, who may not understand, why properties, in which they may be specially interested, have not been surveyed. For this reason, it may be well to say, that the policy of the Survey, as at present administered, is to take up each mineral or geological subject, which may, by proper exploiting, be made to prove a source of wealth to the State, and make a careful study of every occurrence of such subject, within her borders; then, from such field-

work, to prepare a popular report, which shall give, as comprehensive a description of such economic subject, as will at once be of value to the investor or operator, and to the general reading public. To this end, technicalities are avoided, only such use of them being made, as may be necessary to establish the character of the deposits, etc. It is the ultimate purpose of the Survey, to make a complete geological report on each county in the State, accompanied by topographical maps, on which will be indicated the various geological formations and deposits of minerals, occurring in such county. But, in order that this may be faithfully accomplished, and in order that the bringing of the State's mineral resources before the public may not have to wait upon a long and tedious survey of the entire territory, whether it furnish anything of economic value or not, it has been thought best, to make a preliminary survey of the material of probable economic value, first ; to be followed by a full and scientific survey of the entire territory of each county. With this in view, economic surveys of the following subjects have been made : —

The *Marbles*, the *Corundum Deposits*, the *Gold Deposits* (in part), the *Water-powers* (in part), the *Phosphates* and *Marls* (in part), the *Clays* (in part) and the *Artesian-well System* ; and much work has been done, during the past three months, on the *Road-building Materials* of the State. Those subjects, which have thus far been surveyed only in part, as above indicated, are either too extensive, or cover too large a territory, to be included in one of the bulletins of the Survey, which should not exceed one hundred and fifty pages in length.

PERSONNEL

Since my last report, no change has been made in the regular force, except the addition of a watchman for the State Museum. Mr. B. M. Hall was employed, for a short time, as hydrographer, to write up the results of field-work, done under his direction, for the Appendix to the Water-power bulletin, now about to issue from the press.

The following gentlemen have been employed at a nominal sum, during the year, as gauge-readers at the several stations, established along various streams in the State, in the survey of the water-powers: — Messrs. J. H. Lowry, C. E. Melton, J. P. Mercer, S. M. Barnett, Peter Pfeiffer, J. L. Cary, J. A. Moore, J. A. Low and Col. S. M. Carter. Col. Carter has performed the duty gratuitously; and the thanks of the Survey are due to him and to the U. S. Weather Bureau, which has furnished us with reports on the daily gauge-heights of the Oconee river at Dublin. Other gauge-readers, more recently employed, are Messrs. A. A. Almand and S. P. Power, Jr.; and Mr. W. T. Bass, who succeeds Mr. J. P. Mercer at Macon.

EQUIPMENT

To the equipment, as stated in my last administrative report, has been added a laboratory for testing the clays, fitted with the most modern and effective appliances, for ascertaining the points of fusion, tensile strength etc.

Two new wagons, built specially for our field-work, have replaced the old ones, which were nearly worn-out, when I assumed the office of State Geologist. These old wagons were a source of constant expense to the Survey; and I found, that the building of two new ones would be in the line of economy. The old wagons were sold at a fair price, and the money was applied to the settlement of the bill for the new ones. A camera, for use in making micro-photographs, was also added to our equipment, enabling us to reproduce in our reports sections showing rock structure.

The four horses, belonging to the Survey, were sold in the interest of economy, as it had become evident, that it was cheaper for us to hire horses, when actually needed for field use, than to own and board them, at their present depreciated values, when not in service. I suggested this to the Board, at its meeting in January last; but objection was very properly raised, that, as the horses would be needed, for field use in South Georgia, within six weeks time, the sale would best be postponed, till their return from the field. I again called attention to this matter, at the meeting of the Board, June 5th; and a committee was appointed and directed to sell two of the horses, with the understanding, that the other two would be needed within a week or two for field use. Subsequent to this, having learned, that my Assistant would be detained in Atlanta, on laboratory and office duty, longer than was supposed, I notified the Board, at a called meeting in July, and I was directed to sell the other two horses, which I did, as soon as a purchaser could be secured. The funds resulting were applied by the Board to the current expenses of the Survey.

During the year, 41 books and periodicals have been added to the Survey library, making a total, to date, of 352.

FIELD WORK

Work was continued on the Gold deposits of Lumpkin county, last fall; as it had not been quite completed, when my last administrative report went to press. Mr. McCallie was called on to assist me in the extensive field-work, in this county, as urgent office duties required me to spend much of my time in Atlanta.

In connection with the work of preparing an exhibit of the mineral resources of the State, for display at the Tennessee Centennial Exposition,¹ and in pursuance of the regular duties of the State Geologist, a number of short trips were made to various parts of the State, and some interesting material was secured for the permanent exhibit of the State Museum.

The months of February, March and April, and a part of May, were spent by Mr. McCallie in field-work, in south Georgia, making a survey of the Artesian-well system, during which time he covered a considerable number of counties, lying south of the crystalline belt, and practically completing the field-work on this subject. The most of this data he has, since, put in the form of a report, which will soon be ready for publication. In the latter part of July, I assigned him the work of making a survey of the road-building materials of the State, and he has been constantly in the field since then, having visited and made examinations of the road-building materials of Catoosa, Walker, Whitfield, Murray, Gordon, Chattooga, Bartow, Floyd, Polk, Paulding, Cobb, Fulton, Hall, Banks, Franklin, Habersham, Hart, Madison, Clarke, Jackson, Oglethorpe, Elbert, Wilkes, Green, Morgan, Oconee, Walton, Warren, McDuffie,

¹ For full description, see page 12.

Richmond, Hancock and Baldwin counties, in all, thirty-two. Mr. McCallie estimates, that four months more of field-work will complete this subject, in which case we will be able, early next fall, to send a bulletin to press, that will cover the entire State on ROAD-BUILDING MATERIALS.

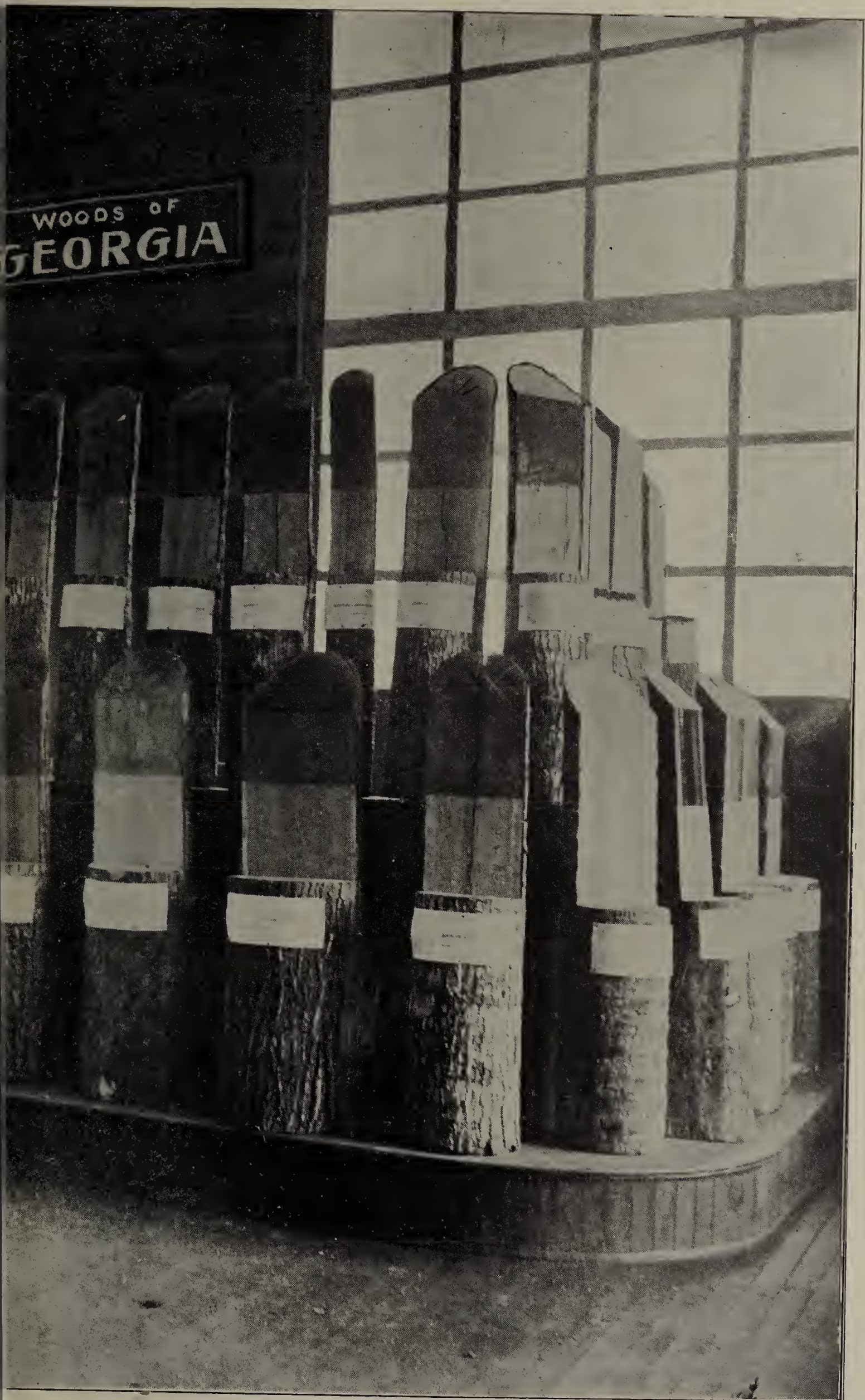
Dr. Ladd has continued the field-work on the CLAYS OF GEORGIA, which was begun early in the year 1896. In reconnaissance, he has located and sampled the fire-clays of the Potomac formation in Muscogee, Marion, Butler, Crawford, Washington, Hancock, Glascock, McDuffie, Richmond and Columbia counties. In detail work, as far as conditions allowed, the clays in Jones, Baldwin, Wilkinson, Twiggs and Bibb counties have been surveyed.

The joint work of this Survey and the U. S. Geological Survey, on the WATER-POWERS OF GEORGIA, has been kept in active operation throughout the year, and Mr. B. M. Hall, Hydrographer of the U. S. Geological Survey for the States of Georgia, Florida, Alabama and Tennessee, has been in charge of the work. Gauge-stations have been in constant operation at Carter's, on the Coosawattee river; at Oakdale and West Point on the Chattahoochee; at Macon on the Ocmulgee; at Resaca on the Oostanaula; at the Seaboard Air Line bridge on the Savannah; at Canton on the Etowah; and at Carey and Dublin on the Oconee. Since July 1st, a station has been in operation at Molena on the Flint river, and one at Carlton, on the Broad river. A station was also established at Almon on the Yellow river, September 10th.

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GEORGIA STATE EXHIBIT OF WOODS,



REPORTS

Of the four reports, mentioned in my last Administrative report, the one on the CLAYS OF GEORGIA was withdrawn from the press, the latter part of March, by my Assistant, Dr. Ladd, in order to incorporate not only additional data collected in the field, since the report had been sent to press, but also a considerable amount of valuable laboratory work, which had been done, during the winter. Both the field and laboratory work having been continued, since then, Dr. Ladd has retained the report, in order to perfect it. Recently, he has placed in my hands a hundred and forty-five pages of typewritten matter, which I am now editing, and which will soon be ready for the press. The remainder of the report, embracing all his field-work, he promises to turn over to me, at an early day. It will then be returned to the printer.

Of the other three reports, all are far advanced; and, in all probability, two of them will issue from the press by the end of this month. The one on the GOLD DEPOSITS, which is by far the largest bulletin, yet issued by the Survey, is about three-fourths in type. An appendix of fifty pages has been added to the Water-power bulletin, already in the hands of the printer, bringing the report on this work of the Survey, up to July 1st, 1897.

I am informed by Mr. McCallie, that his report on the ARTESIAN-WELL SYSTEM OF GEORGIA is more than half completed.

WORK PLANNED

During the coming year, the report on *The ROAD-BUILDING MATERIALS of Georgia* will be finished and the report submitted. Field-work for the second and last of the bulletins on *THE GOLD DEPOSITS* will be undertaken; and for another bulletin on the *CLAYS OF GEORGIA*. The work on the *WATER-POWERS* of the State, it is my purpose to continue, until the subject is complete. This information bids fair to be of great use to Georgia, at no distant day. With the advance of electricity, there will undoubtedly be a greater demand for water-power.

In the latter part of the coming winter, field-work will be continued, and probably completed, on the *PHOSPHATES AND MARLS*. One of the most important pieces of work before us is a survey of the excellent granites and gneisses of this State; and I hope to begin this work, and have it well under way, before October 1st, next. A scientific and practical study of the soils of the State will be a part of the work, to be taken up at as early a date as possible, to be illustrated by properly mounted samples, for exhibition in the State Museum; and a survey of the useful woods of the State, with locations, approximate acreage etc., will be undertaken, as soon as possible. With the small force at my disposal, it is impossible to meet the many demands for information on the large and various mineral and forestry resources of the State. The work could be more rapidly accomplished, and become the sooner available, as a source of revenue, if a larger appropriation, per annum, could be devoted to this effective means of advertising the State's material resources.

STATE MUSEUM

On account of the removal of the greater part of the Museum exhibits to the Tennessee Centennial Exposition and the large amount of necessary detail work, in connection therewith, little has been done, towards increasing the number of specimens on exhibition. Still, 178 new specimens have been catalogued, and a considerable number of others have been collected, which have not yet been identified, catalogued and classified. These will receive proper attention, during the coming winter.

Last entry in catalogue, for year ending October 15th, 1897, 1,542.

Last entry in catalogue, for year ending October 15th, 1896, 1,470.

Five eight-inch dressed cubes of building-stones have been added to the systematic series, and a series of cut quartz and moonstone, secured this Spring, give greater brilliancy to the fine gold and gem case. A number of new specimens have improved the general appearance of the systematic series of ores, and several handsome specimens have been added to the mineral series.

I greatly regret, that the funds, appropriated for the Survey, are not sufficient to enable me to have suitable cases built, for the proper preservation and exhibition of the excellent collection of ores, which I am now compelled to exhibit on tables, where they are at the mercy of relic-hunters and other thoughtless people, who enjoy scratching and otherwise defacing valuable specimens. I hope, by rigid economy, during the next year, to be able to save funds, sufficient to build at least one suitable case for the ore collection.

During the past year, I have had built for the exhibition of the gems and fine gold specimens of Georgia a small, but handsome

mahogany and plate-glass case, which is now on exhibition at the Exposition at Nashville.

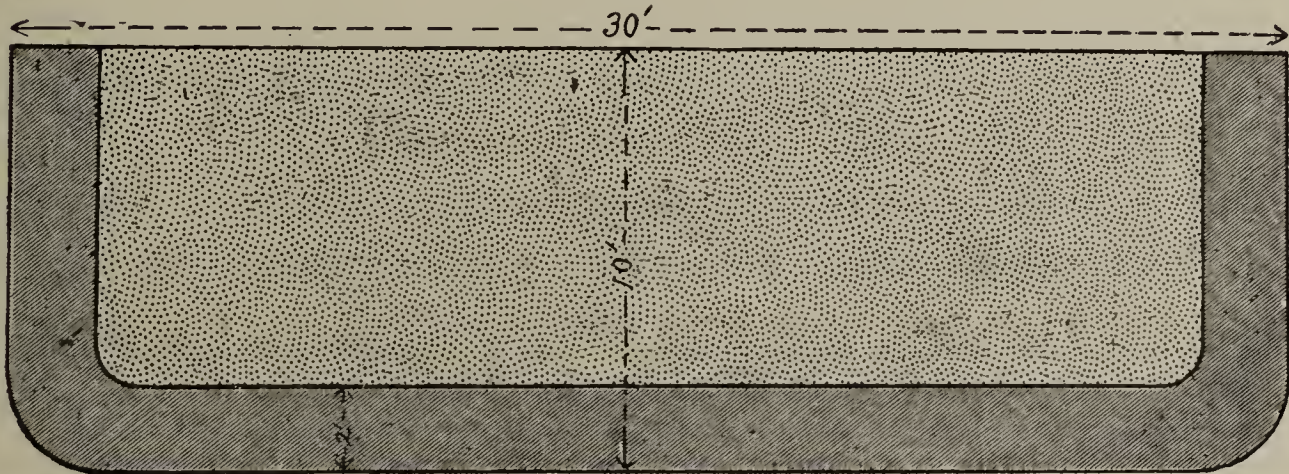
I hope to be able to give a great deal of my personal attention to the Museum, during the coming year, after the exhibits at Nashville shall have been returned to Atlanta. It is my purpose to install such special exhibits, as will illustrate the various economic bulletins, which the Survey publishes, from time to time; such exhibit to have one or more copies of the bulletin, on that particular subject, within easy reach.

MINERAL AND FORESTRY EXHIBIT—TENNESSEE CENTENNIAL EXPOSITION

At its meeting in February, I was directed by the Legislature, to assist the Commissioner of Agriculture, in making a display of the State's material resources, at the Tennessee Centennial Exposition, to open in Nashville, May 1st. As State Geologist, it became my duty, in this connection, to plan, prepare and install such an exhibit of the mineral and forestry resources, as would reflect credit on the State, and attract the attention of investors. To do this properly would necessitate the expenditure of a considerable part of the \$1,500, which the Legislature had directed the Commissioner of Agriculture to expend on a State Exhibit at Nashville; for minerals, building-stones, ores and forestry specimens are all heavy, and expensive to handle. For the purposes of this exhibit, the Director General of the Exposition assigned me a space 71 x 18 feet, on the south side of the Minerals and Forestry Building, beginning in the southeast corner, at one of the principal entrances

to the building. After planning my mineral exhibits, and locating them to the best advantage,¹ I found, that there would be no space for making a forestry display. Communicating this fact to the Director General, and furnishing him a diagram, showing how I proposed to use the space he had assigned me, Georgia was favored, by his recalling 300 square feet of space already assigned, and re-assigning it, for the display of the Woods of this State.² It being evident, that this space would accommodate only a fourth of the Systematic Series of Georgia Woods in the State Museum, I thought it best, not to disturb the series on exhibition in the Museum, but,

Fig. 2



FLOOR PLAN OF PLATFORM USED TO DISPLAY FORESTRY COLLECTION, GEORGIA STATE EXHIBIT, TENNESSEE CENTENNIAL EXPOSITION.

to select a series of the best specimens among our duplicates, and to have these properly dressed, after their arrival in the Exposition building. The exhibits of minerals, ores and building-stones were all on display, on the day of the opening of the Exposition; but the classification and labelling had to be done, subsequently. The preparation of the Woods necessitated a delay in their installation; but, as soon as possible, they were put in a presentable condition, and effectively mounted on a special platform stand, similar to those

¹ See fig. 1.

² See diagram of space, fig. 2.

in the State Museum. Each specimen bore a label, giving its botanical and its common name or names; its locality; and its general distribution throughout the State, indicated by green water-color on a county-map of the State, printed on one end of the label. Over this exhibit was suspended a large sign, 6 feet x 1 foot 2 inches, bearing, in large gold bronze letters on black, the words, WOODS OF GEORGIA.

THE SYSTEMATIC SERIES OF MINERALS, numbering between 400 and 500 specimens, all found in Georgia, was contained in four of the mahoganized cherry and plate-glass cases, belonging to the State Museum. The specimens are effectively mounted on black ebonized blocks, and each bears a neatly printed label, giving the name of the mineral or minerals, composing the specimen, its locality etc.

THE SYSTEMATIC SERIES OF ORES is classified and displayed, on four special tables, each specimen being accompanied by a printed label, similar to the mineral labels, but giving, in addition, the kind of ore exhibited in the specimen. Besides these, the ore collection was supplied with a series of large group-labels, mounted on pedestals, and easily read at a distance of twenty feet.

THE SYSTEMATIC SERIES OF BUILDING-STONES, numbering 55 eight-inch dressed cubes, is displayed on an oblong stepped pyramid, similar to the one in use in the State Museum, for the same purpose. Each cube is mounted on an ebonized block, on which is a printed label, similar to those used for the mineral and ore specimens. Over this pyramid is suspended an eight-foot black and gold bronze sign, bearing, in large letters, the words, BUILDING-STONES OF GEORGIA.

Grouped in three of the large windows, overlooking the mineral exhibits, are fourteen large photographic transparencies, varying in size, from 15 x 22 inches to 25 x 40 inches. The subjects are all

handsome illustrations of Georgia scenery, and include among them such striking objects, as the Witch's Head, at Tallulah Falls; the High Falls of the Towaliga; Toccoa Falls; Fairview Lake in Decatur county; Stone mountain, from its north side, etc. Above these views is suspended a large eight-foot sign, with the words, GEORGIA SCENERY, in six-inch gold bronze letters on black.

SPECIAL EXHIBITS

At my solicitation, a number of producers and finishers contributed, as loans, some very valuable exhibits. THE GEORGIA MARBLE COMPANY, OF TATE, loaned us 4 beautiful eight-foot Corinthian columns, and 4 translucent slabs, of their several kinds of marbles; and THE SOUTHERN MARBLE COMPANY, OF MARBLE HILL, loaned us their magnificent exhibit of white marble, which was a part of the State's exhibit at the Cotton States and International Exposition, and which is fully described in my administrative report for 1896. In addition to this, the SOUTHERN MARBLE COMPANY furnished us a handsome fifteen-foot Corinthian column of white marble, which forms the central piece of our special exhibit of GEORGIA MARBLE. THE KENNESAW MARBLE COMPANY, OF MARIETTA, furnished for this exhibit an exquisite wainscoting of Creole marble, which was fitted along the wall, just back of this special marble exhibit, besides lending us two attractive monuments of medium size, and a vase, mounted on a turned and polished column. One monument and the vase were of Creole marble, while the other monument was of Etowah. MESSRS. GEORGE B. SICKELS & Co., OF TATE, furnished a handsome tiled floor, of special design, of the Creole, Etowah and Kennesaw Marbles; and THE GEORGIA MAR-

BLE FINISHING WORKS, OF CANTON, contributed two handsome monuments, one of Etowah and the other of Creole Marble. Two large vases on turned columns of the white, pink and mottled black and white marbles, and a very pretty Creole monument, were contributed by THE BLUE RIDGE MARBLE COMPANY, OF NELSON.

The massive exhibit of white marble from THE SOUTHERN MARBLE COMPANY, not including the fifteen-foot column, had to be displayed on special space, at the west end of the Minerals and Forestry Building, assigned by the Director General for that purpose. The several columns, monuments and vases were mounted on the marble tile floor, which was about 18 feet square; and, as before stated, the marble wainscoting was fastened up against the wall, adjoining this space. From the large window above this, four of the glass panes were taken, and the four translucent marble slabs were substituted, so that the light passed through, producing a beautiful effect. A similar slab of serpentine, received from THE VERDE ANTIQUE MARBLE COMPANY, OF CHICAGO, was placed in another window; but, on account of the dark green of the serpentine, not sufficient light was transmitted to render it as effective as was desired. Over the special marble exhibit was hung an eight-foot black sign, on which, in six-inch gold bronze letters, were the words, GEORGIA MARBLE.

Besides the special exhibit of marbles, an exquisite eight-foot column of the serpentine from Holly Springs, in Cherokee County, and a card receiver on a polished turned column of the same material, were loaned by THE VERDE ANTIQUE MARBLE COMPANY, OF CHICAGO, whose quarries are at Holly Springs. The large column was surmounted with a Corinthian cap covered with gold leaf, upon which rested a polished ten-inch ball of the serpentine. For brilliancy of effect, this special exhibit is hardly equalled, by anything at the Exposition.

Other special exhibits, were a series of the Rockmart Slate, which had been furnished the Geological Survey for the Cotton States and International Exposition, by THE GEORGIA SLATE COMPANY, OF ROCKMART; a handsome display of the Bowden Lithia Water, loaned by THE BOWDEN LITHIA WATER CO., OF ATLANTA, in pint, quart and half-gallon bottles, arranged on a pyramid and surmounted by a car-boy of this water; a display of sewer-pipe, furnished by H. STEVENS' SONS, OF MACON; a large polished slab of blue granite from the Venable & Collins quarry at Oglesby, loaned by THE VENABLE AND COLLINS GRANITE COMPANY, OF ATLANTA; and two large, dressed blocks, one of sand-stone from Catoosa county, belonging to the State Museum, and the other of Sparta granite, from Hancock county, the gift of THE GEORGIA QUINCY GRANITE COMPANY, OF MACON.

The special fine case, containing the collection of gems, gold nuggets and other fine gold specimens, which has stood in the corridor of the capitol, in front of my office, completes the mineral display. Across the exhibit of minerals, ores, building-stones etc., hangs a ten-foot sign, with the word GEORGIA, on each side of it, in eight-inch gold-bronze letters on a maroon background, which can be easily read, the entire length of the building.

This exhibit of Minerals and Forestry of Georgia has been profusely complimented, and it is said, by several of the principal officers of the Exposition, to be the best exhibit they have. I have taken much interest, in making this display of Georgia's mineral and forestry resources one, that would be, in every way, creditable to this great State; and it has been said, by persons competent to judge, that no State exhibit, from any Southern State, at any Exposition, has equalled it.

MISCELLANEOUS WORK

In addition to the regular duties of State Geologist, I have been able to determine and report on 108 specimens of minerals, sent in by persons throughout the State, for examination and report.

ACKNOWLEDGMENTS

The following gifts, received from friends of the Survey, during the year, have been catalogued as follows: —

MR. N. Z. GLENN, THOMASTON, GA.

- One specimen of Corundum Crystals, Upson County.
- One specimen of Feldspar, Upson County.
- One specimen of Feldspar and Quartz, Upson County.
- One specimen of Tabular Quartz, Upson County.
- Three specimens of Feldspar, Upson County.
- One specimen of Staurolite Crystal, Upson County.
- Two specimens of Kyanite Crystals, Upson County.
- One specimen of Ilmenite, Upson County.
- One specimen of Magnetite, Upson County.
- One specimen of Kyanite Crystal, Upson County.
- Seven specimens of Corundum Crystals, Upson County.

MR. JOHN B. ATKINSON, PRESIDENT ST. BERNARD COAL CO., EARLINGTON, KY.

- One specimen of Free Gold in Quartz, Tahloneka Mine, Dahlonega.

JUDGE W. W. MURRAY, HUNTINGDON, TENN.

- Five specimens of Free Gold in Quartz, Preacher Mine, Dahlonega.
- One specimen of Free Gold with Auriferous Pyrite in Quartz, Tahloneka Mine, Dahlonega.

One specimen of Native Gold in Quartz, Singleton Mine, Dahlonega.

One Specimen of Auriferous Pyrite in Quartz, Mary Henry Mine, Dahlonega.

MESSRS. VENABLE BROTHERS, ATLANTA, GA.

One specimen of Granite (8-inch cube), Stone Mountain, DeKalb County, Ga.

One specimen of Granite (8-inch cube), Lexington.

MR. GEORGE H. CLARKE, CEDARTOWN, GA.

One specimen of Iridescent Limonite, Cedartown.

CAPT. J. W. WEAVER, DAHLONEGA, GA.

Six specimens of Free Gold with Limonite in Quartz, Singleton Mine, Dahlonega.

MR. J. G. FANNING, ADASBURG, WILKES COUNTY, GA.

One specimen of Quartz, Adasburg, Wilkes County.

CAPT. J. A. COTTEN, THOMASTON, GA.

One specimen of Quartz Crystal, Wilmot Farm, 3 miles S. E. of Thomaston; Upson County.

One specimen of Limonite, Talbot County.

One specimen of Corundum Crystals, Lot 89, 16th District, Upson County.

One specimen of Egg-shaped Quartz Pebble, 7 miles S. E. of Thomaston, Upson County.

MR. J. J. WALLACE, BEN HILL, GA.

Fifty specimens of Quartz Crystals, Fulton County.

MR. J. E. COLWELL, ATLANTA, GA.

One specimen of Asbestos with Decomposed Chlorite, Paulding County.

MR. JOHN HUFF, DAHLONEGA, GA.

Five specimens of Free Gold in Quartz, Calhoun Mine, near Dahlonega.

MR. L. A. JEHAN, CARTERSVILLE, GA.

Three Pyrite Crystals, Gwinnett County.

MR. E. O. BUTTS, MADISON, GA.

One specimen of Limonite, near Gainesville.

MR. T. D. O'KELLEY, CALEB, GA.

One large Muscovite Crystal, Gwinnett County.

MR. W. W. GRANT, ATLANTA, GA.

One specimen of Chromite, Meriwether County.

ACKNOWLEDGMENT TO THE ADVISORY BOARD

In conclusion, it gives me pleasure to acknowledge my indebtedness to the members of the Advisory Board, for their kind considerations of the needs of the Survey, and for their friendly interest in our work. I am

Very respectfully yours,

W. S. YEATES,

STATE GEOLOGIST.

229a
1898

GEOLOGICAL SURVEY OF GEORGIA

W. S. YEATES, State Geologist

ADMINISTRATIVE REPORT

OF THE

STATE GEOLOGIST

For the Year Ending

October 15th, 1898

ATLANTA, GA.
GEO. W. HARRISON, STATE PRINTER
(Franklin Prtg. and Pub. Co.)
1898

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With the compliments of

N. S. Yeates,

State Geologist.



GEOLOGICAL SURVEY OF GEORGIA

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THE ADVISORY BOARD
of the
Geological Survey of Georgia

(Ex-Officio)

HIS EXCELLENCY, W. Y. ATKINSON, Governor of Georgia

PRESIDENT OF THE BOARD

HON. R. T. NESBITT ----- Commissioner of Agriculture
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HON. J. M. TERRELL ----- Attorney-General

ADMINISTRATIVE REPORT

GEOLOGICAL SURVEY OF GEORGIA,
ATLANTA, October 16th, 1898.

*To His Excellency, W. Y. ATKINSON, Governor and President of
the Advisory Board of the Geological Survey of Georgia:—*

Sir:— I have the honor to submit my administrative report, for the year ending October 15th, 1898.

The administrative duties of the office have, as usual, required a large portion of my time; but the preparation of my report on the gold deposits of Lumpkin county, and the editing of the extensive bulletin, on the occurrence and development of gold in those counties, included in the Dahlonega and Hall County gold belts, have occupied much of my own time, during the year. Numerous inquiries, by letter, as to the character and availableness of various mineral resources of Georgia, have been received from people outside of the State; and many such have been received from our own people. Much attention has been called to the material resources of the Southern States, during the past few years, especially to those of Georgia; and these inquiries come, generally, from persons seeking investments, either for themselves, or for others, for whom they are agents.

During the past field-season, my time has been so constantly occupied by administrative duties, and in editing reports, that I have been

able to make only short trips into the field, here and there. Probably, the most important one of these was made, in answer to a request of the Mayor of Columbus, asking, that I make a special examination of the country around that city, and inform him, if it were at all feasible, for the city, or for individuals, to bore for a supply of artesian-well water, within the corporate limits. I made the necessary examination; and, finding that the Geological conditions would not justify a favorable report, I was compelled to report against the project. By this report, the city was saved the useless and heavy expense of an experiment, which, I was informed, many of the citizens, up to that time, had favored.

Last Spring, in order to illustrate the value of the aluminum ore of Georgia, at The Omaha Exposition, and with a view to incorporating the exhibit in the State Museum, on its return to Georgia, I corresponded with The Pittsburg Reduction Company, of Pittsburg, Penn., and with a number of aluminum manufacturers, and secured the gift of 57 specimens of wire, angles, toilet articles, tableware, cooking utensils etc., made from Georgia bauxite. With these, and handsome specimens of the ore, already in the Museum, I was able to make up a very attractive case, illustrating this valuable mineral resource, in which Georgia is probably richer, than any other State in the Union.

Requests for the identification of minerals continue to come to my office, from people living in different parts of the State, some coming by mail, and some by express; while others are made by persons visiting Atlanta, and bringing minerals with them for identification. Of these, I have identified and reported on 78 minerals and rocks, during the year.

WORK OF THE ASSISTANT GEOLOGISTS

In October and November, 1897, after my last report was submitted, Mr. McCallie continued field-work on the road-building materials of Georgia, which work he continued, during a part of the past season. Having collected enough data, to justify the publication of a bulletin on this subject, he was recalled from the field, August 1st, and was directed to begin the preparation of his report, which, he estimated, would be ready for publication, the last of December. During the season, his operations covered the counties of Butts, Jasper, Jones, Monroe, Upson, Pike, Talbot, Coweta, Carroll, Douglas, Cobb, Baldwin, Decatur, Campbell and Henry, these counties, with those previously surveyed, practically completing the field-work on the road-building material in the northern and central parts of the State. This work has revealed the fact, that these sections can supply an abundance of excellent road-building material, the trap rocks, which are the best for macadamizing roads, being plentiful throughout the Crystalline Belt, and much of it, most favorably located for transportation by railroads.

The office work, done by Mr. McCallie, has consisted in finishing the report on the Artesian-Well System of Georgia, and in writing a considerable part of the report on the Roads and Road-Building Materials of Georgia.

As will be seen, hereafter, Dr. Watson's tenure of office, as Assistant Geologist, began, the middle of last April. Before designating his field-work, for the season, I assigned to him, as a specialist, the petographic study of a number of rocks, which I had collected, in my investigation of the geology of the gold belt in

Lumpkin county. His results are published, in the Bulletin on the Gold Deposits, as an addendum to that division of my report.

As the Survey is not provided with a regular chemist, in tendering him the appointment of Assistant Geologist, I was compelled to couple with it the duty of doing, at my discretion, such chemical investigation, as might be required by the Survey. In the performance of this duty, he has made assays of 14 samples of gold ores, and has identified about 30 minerals and rocks.

After his discharge of these duties in the laboratory, I assigned Dr. Watson to a systematic study of the granites and gneisses of the State, one of the most important of its economic mineral resources, to be exploited. His special training rendered his assignment to this duty, of exceptional value to the State; and, as a result, I can, with confidence, predict a valuable report, on this great economic interest. Thus far, he has completed the field-work on the granites and gneisses of DeKalb, Gwinnett, Rockdale, Newton, Morgan, Greene, Hancock, Warren, Wilkes, McDuffie, Columbia and Richmond counties; and he is now actively engaged on this work, in other counties. His reports, so far, are most encouraging. In the counties above named, he has carefully collected, from each locality visited by him, specimens for laboratory study, and 12-inch cubes, in duplicate, from which 8-inch cubes are to be dressed and added to the systematic collection of Georgia's building-stones, which is now on display at THE TRANS-MISSISSIPPI AND INTERNATIONAL EXPOSITION, at Omaha, Nebraska. Dr. Watson expects to have this report ready for the press, not later than next Spring.

FIELD-WORK ON THE WATER-POWERS

Mr. B. M. Hall, of Atlanta, Hydrographer of the U. S. Geological Survey for Georgia, Florida, Alabama and Tennessee, has had immediate charge of this work, in the plan of co-operation between the Geological Survey of Georgia and the Federal Survey. Gauge-stations have been maintained, continuously, since my last annual administrative report, at the following stations:—Carter's on the Coosawattee river; Resaca, on the Oostanaula; Canton, on the Etowah; Oakdale and West Point, on the Chattahoochee; Macon, on the Ocmulgee; Carlton, on the Broad; and Augusta, on the Savannah. The station at Almon, on the Yellow river, was discontinued, December 31st, 1897, as it was only intended to continue it, long enough to get the average low-water of this small stream. Dublin station, on the Oconee river, was established February 11th, 1898, and Carey station, on the same river was discontinued Mar. 31st, 1898. The station at Albany, on the Flint river, was established, January 1st, 1898, and that at Molena, on the same river, was discontinued, June 2nd, of this year. A more advantageous point being found, a mile below Oakdale on the Chattahoochee river, a station, designated as Oakdale (Lower Gauge) was established June 1st, 1898; and the station at Oakdale was discontinued, July 9th, following. A station was established on the Tugalo river, at Madison's Ferry, July 19th, and that, at the S. A. L. bridge, on the Savannah river, was discontinued, August 9th.

Mr. Hall and his assistants, Messrs. Max Hall, K. T. Thomas and J. C. Conn, have measured the velocities of a number of the

streams at various seasons and stages, during the year, using the latest improved and most reliable current-meters, for the purpose. I hope to be able, soon, to have the topographic survey of the streams continued, and to locate such falls and shoals, as have not, hitherto, been mapped. This is a matter of great importance to the State; and, but for the fact, that the appropriation for the Survey has been, and is, now, too meagre, to do this and other urgent work, at the same time, this work would now be well advanced.

PERSONNEL OF THE SURVEY

Mr. S. W. McCallie, Assistant Geologist, still continues with the Survey.

In April of this year, I appointed to the position, made vacant by the resignation of Dr. Ladd, Assistant Geologist, near the close of the field-season of 1897, Dr. Thomas L. Watson of Virginia, who came to the Survey, admirably equipped for its work.

After graduating at the Agricultural and Mechanical College of Virginia, he was retained for five years, as instructor in Geology, Mineralogy and Chemistry in the College, and as Assistant Chemist of the Virginia Experiment Station, which position he voluntarily resigned, in order to continue his scientific studies, without trammel. For some time, he pursued post-graduate work at the University of Virginia, after which he spent the equivalent of three scholastic years at Cornell University, graduating from that institution, in

June, 1897, with the degree of Doctor of Philosophy. A part of that summer, he spent, as Assistant Geologist on the Geological Survey of Indiana, investigating the coal-fields of that State; but he was soon called home by the serious illness of a relative; and, while there, he was attacked by malarial fever; and was not able to resume his duties. He then began a study of some of the eruptive rocks of Virginia, concluding this work at the National Museum in Washington, where he spent last winter and part of the spring.

The application of Dr. Watson, for the vacancy on this Survey, was accompanied by the strong endorsements of his professors at the Agricultural and Mechanical College of Virginia, the University of Virginia, and Cornell University; also by copies of published original papers by him, on chemical and geological subjects.

At the regular session of the Legislature in 1897, the law, requiring the Commissioner of Agriculture to furnish whatever clerical help might be needed by the Geological Survey, was repealed. It then became necessary for the Survey to employ a clerk. So, with the consent of the Advisory Board, I appointed as clerk, January 1st, 1898, Mr. F. E. Ellis, who, for nearly two years, had been serving in that capacity, as an employee of the Department of Agriculture.

A watchman for the State Museum has been employed, continuously, during the year.

The collecting of data for the next report on the water-powers has necessitated the employment of gauge-observers, at the several stations on the rivers indicated, as follows: —

Observer	Station	River
H. S. Weems ¹	Carter's	Coosawattee
S. M. Barnett	Resaca	Oostanaula
Jas. A. Low	Canton	Etowah
W. M. Towers ¹	Rome	Coosa
J. H. Lowry	Oakdale	Chattahoochee
C. H. Turner	" (Lower Gauge)	"
C. E. Melton	West Point	"
J. A. Moore }	Molena	Flint
S. K. Moore }		
Jno. E. Clark ²	Albany	"
A. A. Almand	Almon	Yellow
W. T. Bass	Macon	Ocmulgee
J. L. Cary	Carey	Oconee
Jasper Young	Dublin	"
S. C. Cobb	Madison's Ferry	Tugalo
S. P. Power, Jr.	Carlton	Broad
P. J. Pfeiffer	S. A. L. Bridge	Savannah
J. M. Youngblood ³	Augusta	"

With the exception of Messrs. Weems and Towers, who generously rendered the service, without compensation, and Mr. Clark, the Weather Bureau observer, and Mr. Youngblood, observer for the City of Augusta, these gentlemen were paid a small amount for their services. As before stated, Mr. B. M. Hall, Hydrographer for the U. S. Geological Survey for Georgia, Florida, Alabama and Tennessee, has been directly in charge of this field-work. Mr. Hall's services have been given, without compensation, for the sake of the co-operation between this and the Federal Survey.

¹ Service furnished gratis to the Survey. ² Service furnished by the U. S. Weather Bureau.

³ Service furnished by the City of Augusta.

EQUIPMENT

I have not found it necessary, during the year, to do much towards increasing the equipment of the Survey; as it is already very effective, enabling us to do our work to the best advantage. Machinery for testing the strength of building-stones, the resisting properties of road-material and other like testing machinery, are desirable; but, on account of insufficient appropriation, we find it necessary, to avail ourselves of such outside help, as we are able to secure.

During the year, the Survey library has been increased by 65 books and periodicals, making a total of 417. These have been received mostly from our exchanges.

REPORTS

Since my last annual Administrative Report, three economic reports have issued from the press, as follows: — Bulletin 3 – A, A Preliminary Report on a Part of the Water-powers of Georgia; Bulletin 4 – A, A Preliminary Report on a part of the Gold Deposits of Georgia; and Bulletin 5 – A, A Preliminary Report on a Part of the Phosphates and Marls of Georgia. These have had, and are now having, considerable distribution over different sections of the country. There has been a large demand for the Gold report, from various parts of this country and from England. These demands are being filled, as rapidly as possible. Two hundred copies

of this bulletin were sent to Ex-Governor Northen, the State's Commissioner at the Omaha Exposition, for distribution among mine investors visiting the exposition.

The report on the Clays of Georgia, which was mentioned, in my last Administrative Report, as having been withdrawn from the press by Dr. Ladd, was not entirely returned to me, until the 3rd day of this month, Dr. Ladd having left the Survey and the State, without finishing the report. Assuming new duties, this report was not completed, until recently. It is now in press; and, in due course of time, it will be issued, as Bulletin 6 – A, A Preliminary Report on a Part of the Clays of Georgia.

The Report on The Artesian-Well System of Georgia was placed in my hands, some time ago, by my Assistant, Mr. McCallie, to be edited and published. I shall place this in the hands of the printer, in a few days,¹ to be published, as Bulletin No. 7, A Preliminary Report on the Artesian-Well System of Georgia.

Field-work is now finished on the first report on the Roads and Road-building Materials of Georgia; and I am informed by my Assistant, that the work of writing the report is well advanced. This will be issued as Bulletin 8 – A, A Preliminary Report on a Part of the Roads and Road-building Materials of Georgia.

The field-work for a report on the granites and gneisses of Georgia was begun this summer; and it is now well under way. Before the present field-season closes, enough data will have been collected, to justify the publication of the first report of this series, to be known, as Bulletin 9 – A, A Preliminary Report on a Part of the Granites and Gneisses of Georgia.

¹ Since the date of this report, the report on the Artesian-well system of Georgia has been placed in the hands of the State Printer, and is now going through the press.

WORK PLANNED

On account of the resignation of Dr. Ladd, and the urgent necessity, that Mr. McCallie remain on office duty, in order to complete the report on the Artesian-Well System, I was unable to have the field-work resumed on the Phosphates and Marls, in the early Spring. It is my purpose to have this work continued in March, April and May next, beginning, if the weather is favorable, even before March. As soon as the administrative duties of my office will permit, I shall take the field, to collect data for a second report on the Gold Deposits of Georgia. This report will include those counties, having gold deposits, and not included in Bulletin 4 - A. When the field-work on these counties is finished, all the counties, reported on, in that bulletin, will be again visited; and all new developments, and all properties not discovered in the first survey, will form the subject for an additional report, to be included in Bulletin 4 - B, in this way bringing up to date all the developments in the gold-mining industry of Georgia.

STATE MUSEUM

Most of the specimens of the State Museum are now on display at the Omaha Exposition, having been turned over to THE GEORGIA STATE COMMISSION, TRANS-MISSISSIPPI AND INTERNA-

TIONAL EXPOSITION, in accordance with a resolution of the last General Assembly.

One of the most notable additions to the Museum, during the past year, was a collection of toilet articles and household- and kitchen-ware, made of aluminum, extracted from Georgia bauxite, by THE PITTSBURG REDUCTION COMPANY, of Pittsburg, Penn. This collection, I secured from a number of aluminum manufacturers, whose friendly interest I have duly acknowledged, under another division of this report. In connection with a series of aluminum ore (bauxite) from different mines in Georgia, I have arranged this collection of manufactured products as an exhibit, and installed it, in a plate-glass exhibition case, of the kind used for displaying the systematic collection of minerals. It is now on exhibition at Omaha. Since the founding of the State Museum in 1895, fourteen handsome gold nuggets, from the Hamby Mountain mine, in White county, have formed an important feature of this exhibition of Georgia's mineral resources. These nuggets were kindly loaned to the State by their owner, Mr. John Martin, of Cleveland, Georgia. In the early part of the year, Mr. Martin disposed of them; and, in order to save them from the melting-pot, it became necessary for the Geological Survey to purchase them, for a permanent exhibit in the Museum. THE GRAMLING-SPALDING CO., of Atlanta, kindly gave the State the refusal of these nuggets, at their actual gold value. Having ascertained this value, I was instructed by the Advisory Board to purchase them, thereby saving an exhibit of great worth, for advertising the State's material resources. I was also directed by the Board, to purchase a handsome collection of nine gold nuggets from the Loud mine in White county, owned by Mr. R. K. Reaves, of Athens, Ga. This is a splendid addition to the State collection, and attracts much

attention from visitors. Both the Martin and Reaves collections of nuggets can be readily sold, for the amounts paid for them, if it should ever become necessary for the State to dispose of them. I heartily concur in the action of the Board, in saving these valuable specimens, to constitute an attractive object-lesson advertisement for Georgia. These nuggets are mounted on black velvet pads, with suitable printed labels, and are displayed with other handsome free-gold specimens, and some of Georgia's gems, in a mahogany case with plate-glass top.

During the year, 232 specimens have been catalogued and added to the Museum collections.

Last Catalogue Entry, for Year Ending October 15th, 1898. 1,691

Last Catalogue Entry, for Year Ending October 15th, 1897. 1,542

I am constrained, to call the attention of the Legislature, through Your Excellency, to the necessity for suitable cases, in which to preserve and exhibit the handsome specimens of ores and building-stones, which I have been compelled to display on cheap tables. These specimens, which have been collected, at much expense, are subject to the handling and mal-treatment of visitors; and some vandals have gone so far, as to scratch and abuse some of the specimens exposed, and to even tear from the mounting-blocks the printed labels, describing the specimens. I had hoped, to be able to build one or two display-cases for the ore collection, from the regular appropriation of the Survey, during the past year; but it became necessary for me to employ a clerk, to be paid from this fund; and, for this reason, I was unable to build the cases.

ACKNOWLEDGEMENTS

The following gifts, received from friends of the Survey, during the year, have been catalogued, as follows: —

MR. W. L. DARNELL, ATLANTA, GA.

Three specimens of Pyrite in Quartz, from Fulton County.

MR. H. H. SUMMEROUR, DULUTH, GA.

Four specimens of Free Gold in Quartz, from Milton County.

MRS. F. B. ARRINGTON, QUITMAN, GA.

One specimen of Silicified Coral Geode, from Brooks County.

THE PITTSBURG REDUCTION CO., PITTSBURG, PENN.

Thirteen specimens of Aluminum Angles, Wire Etc., manufactured from the product of Georgia ore.

THE ILLINOIS PURE ALUMINUM CO., LEMONT, ILL.

Fifteen specimens of Aluminum Ware, manufactured from the product of Georgia ore.

MESSRS. S. D. CHILDS & CO., CHICAGO, ILL.

Nineteen specimens of Aluminum Ware, manufactured from the product of Georgia ore.

MESSRS. SIDNEY SHEPARD & CO., BUFFALO, N. Y.

Three specimens of Aluminum Ware, manufactured from the product of Georgia ore.

THE FLORENCE MANUFACTURING CO., FLORENCE, MASS.

Four specimens of Aluminum Ware, manufactured from the product of Georgia ore.

MESSRS. REYMOND & GOTTLOB, NEW YORK CITY.

Three specimens of Aluminum Ware, manufactured from the product of Georgia ore.

MR. J. W. BISHOP, WOODBURY, GA.

One specimen of Quartz and Chlorite, from Meriwether County.

MESSRS. PATTERSON BROTHERS, ATLANTA, GA.

One specimen of Marble, from Catoosa County.

MR. J. M. POUND, POUND P. O., GA.

One specimen of Quartz, from Upson County.

MR. J. M. DORSON, SWIFTON, GA.

One specimen of Quartz, from Upson County.

MR. H. L. BENNETT, ATLANTA, GA.

Thirty specimens of Corundum, from Cobb County.

MESSRS. W. M. SCOTT & CO., ATLANTA, GA.

One specimen of Beryl, from Georgia.

AWARDS AT THE TENNESSEE CENTENNIAL EXPOSITION

It is gratifying, to be able to say, that Georgia was the only State, at THE TENNESSEE CENTENNIAL EXPOSITION, that was awarded a gold medal for its *Display of Minerals, Ores and Building-stones*. A silver medal, the highest prize in the Forestry Department, was awarded to Georgia, for its systematic collection of *Forest-tree Sections*. This display was made from the duplicates of the collection, on exhibition in the State Museum. A silver medal was also awarded to Georgia, for the best display of Verde Antique. This exhibit consisted of a handsome polished 8-foot column of serpentine, surmounted with a gold-leaf-covered Corinthian cap, on which rested a 10-inch polished serpentine ball; and a card-receiver of serpentine, on a turned and polished column of the same material. This display was kindly prepared for, and loaned to the State, by THE VERDE ANTIQUE MARBLE CO., of Chicago, it being the product of their quarries, at Holly Springs, Cherokee County, Ga.

THE STATE MUSEUM EXHIBIT AT THE TRANS-MISSISSIPPI AND INTERNATIONAL EXPOSITION

In accordance with the resolution of the General Assembly, at its last session, authorizing Your Excellency to appoint a Commission, to collect and make an exhibit for the State at the Trans-Mississippi and International Exposition at Omaha, Nebr., and directing that the collections of the State Museum be turned over to that Commission, I, as *ex-officio* Curator of the Museum, delivered the fruit collection, four cases of the Mineral collection, four tables of the Ore collection, and the collection of Building-stones, to Ex-Governor W. J. Northen, Chairman of the Commission. I also secured, for the Commission, from THE GEORGIA MARBLE CO., of Tate, Ga., the 4 handsome Corinthian columns of Pickens county, marbles of various colors, which they had loaned me for the exhibition at the Nashville Exposition. As the arrangement and classification of the minerals and ores required knowledge of a technical nature, it was necessary, for some one from the Survey to go to Omaha, to install these collections. On account of urgent work on the report on the Gold Deposits, which was then going through the press, it was not expedient for me to go. But, having been furnished a plan of the first floor of the Georgia State Building by Governor Northen, I laid out the plan, for installation, on paper, and sent my clerk, Mr. F. E. Ellis, whom I had trained to Museum work, to carry out the details of classification and installation. The collections being classified in the boxes, in which they were packed, it only remained to transfer them from the boxes to the cases, in their regular order. I have every reason to believe, that

this work was done satisfactorily. Subsequently, on account of insufficient space, it became necessary for Governor Northen to make some modifications of my plans, in order to accommodate the Fruit exhibit, on the first floor. But this was done, doubtless, without affecting the attractiveness of the display.

ACKNOWLEDGEMENT TO THE ADVISORY BOARD

In concluding this report, it affords me much pleasure, to testify to the pleasant relations, that continue to subsist between the members of THE ADVISORY BOARD and myself; and I wish to acknowledge my thanks to them, for the uniform courtesy and kind consideration, with which I have been treated, at their hands.

Very respectfully yours,

W. S. YEATES,

State Geologist and Ex-Officio Curator of the State Museum.



With the compliments of

W. S. Yeates,

State Geologist.



GEOLOGICAL SURVEY OF GEORGIA

W. S. YEATES, State Geologist

ADMINISTRATIVE REPORT

OF THE

STATE GEOLOGIST

For the Year Ending

October 15th, 1899

ATLANTA, GA.

GEO. W. HARRISON, STATE PRINTER
(Franklin Prtg. and Pub. Co.)

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THE ADVISORY BOARD
of the
Geological Survey of Georgia

(Ex-Officio)

HIS EXCELLENCY, A. D. CANDLER, Governor of Georgia

PRESIDENT OF THE BOARD

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- HON. G. R. GLENN Commissioner of Public Schools
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- HON. J. M. TERRELL Attorney-General

ADMINISTRATIVE REPORT

GEOLOGICAL SURVEY OF GEORGIA,
ATLANTA, October 16th, 1899.

*To His Excellency, A. D. CANDLER, Governor, and President of
the Advisory Board of the Geological Survey of Georgia,*

SIR :— I have the honor to submit my administrative report, for the year ending October 15th, 1899.

With the increasing years, the duties of administration of the office have claimed an ever increasing portion of my time ; and so exacting have they been, during the past year, that I have been prevented from doing much systematic field-work. Many inquirers for information, concerning the mineral resources of the State, have communicated with me, both by mail and in person ; and never was the Survey in better position to furnish such information ; for the work on the various economic problems has taken at least some member of the Survey into almost every county in the State. While this has been done, for the study of some particular problem, on which such geologist was at the time engaged ; yet much valuable information has been gained on many other subjects, which is not only useful for general information at the present time, but which furnishes the nucleus for future work on other problems.

Much of my time, when not in the field, has been devoted to editing reports and reading and correcting proof-sheets from the

two reports, mentioned in my last administrative report, as being in press. Each of these, when issued, numbered over 200 pages. In addition to the editing of the greater part of these reports, during the past year, I have completely edited a report of the Roads and Road-building Materials of the entire State, which, when published, will make a bulletin, of not less than 350 pages. My field-work has consisted in making a number of special trips to different parts of the State, and in getting the field-work on the second report on the Gold Deposits of the State fairly well under way. As this is by far the most pleasant part of my duties, and as I am so anxious for the Survey to accomplish the maximum amount of work each year, it is a matter of much regret to me, that more of my own time could not have been devoted to field-work.

The work of identifying minerals, for the people from different parts of the State, applying for such work, has greatly increased, and there seems to be a very general desire for information, as to the nature and uses of minerals, found in various parts of the State. Of such material sent, or brought in, to my office for examination and report, I have identified and reported on 444 minerals, rocks and ores, in almost all cases, giving my opinion as to their commercial value.

WORK OF THE ASSISTANT GEOLOGISTS

After my last administrative report was finished, Mr. McCallie continued the office-study and writing of his report on the Roads and Road-building Materials of Georgia. Contrary to his expect-

tation, this report was not finished, until July 1st, the necessary microscopic study of a large number of rock-sections requiring a great deal of time. As soon as this report was completed, he began a survey of the Iron Ores of the State, to which work I had previously assigned him, he having received verbal instructions, to include a survey of the Coal Deposits, also, when he should reach Dade and Walker counties. While the field-work on these subjects was assigned to Mr. McCallie, a study of their chemical side was assigned to Dr. Watson, their work to be published jointly.

Beginning work about the 5th of July, Mr. McCallie has finished the survey of the Iron Ores of Polk and the greater part of Bartow county. It is anticipated, that he will finish Floyd county, also, before the season closes.

After the date of my report of last year, Dr. Watson continued field-work on the Granites and Gneisses of the State, until the close of the field-season, when he returned to the laboratory, and began the systematic chemical investigation of these stones. This work was continued steadily, until May 19th, when he again resumed field-work, for the further study of these valuable deposits. Having accumulated, by August 1st, sufficient field-data, to justify the publication of a bulletin on this subject, which should include the most important granite quarries of the State, I assigned to Dr. Watson the work of making a survey of the Aluminum and Manganese deposits of the State. This work he continued, until September 10th, when, on account of his occupying the dual position of Assistant Geologist and Chemist to the Survey, it became necessary for me to recall him from the field to the laboratory, to resume the chemical work. Summing up his work during the year, he has completed a survey of the Granites and Gneisses in

the counties of Baldwin, Putnam, Madison, Oglethorpe, Elbert, Clarke, Pike, Spalding, Meriwether, Heard, Troup, Coweta, Campbell and Fayette, which, with those counties mentioned, in this connection, in my last Administrative Report, make a total of 26 counties, in which the field-work on the Granites and Gneisses has been completed. When it is stated, that this territory comprises by far the most important of the granite areas of the State, some idea may be had of the value and extent of this work. In his field-work on the Aluminum and the Manganese deposits, Dr. Watson completed the survey of the former, all of which lay in the counties of Polk, Bartow, Floyd, Chattooga and Walker; also, a part of the Manganese deposits of Bartow and Floyd counties.

In the laboratory, 59 complete chemical analyses of the Granites and Gneisses of the State were made, during the year, to be published in the forthcoming bulletin on this subject. Other work in the laboratory consisted in making 11 assays of gold-ore samples, and in the chemical examination and the identification of 15 specimens of clays and other minerals and rocks.

FIELD-WORK ON THE WATER-POWERS

The co-operation between this Survey and the U. S. Geological Survey, in an economic examination of the water-powers of the State, has been maintained, but with a decreasing cost to the State, in that much of the service has been furnished *gratis* by the U. S. Weather Bureau, from such points, as were occupied as stations by the Bureau. Mr. B. M. Hall, of Atlanta, Hydrographer of the

Federal Survey for this and several other Southern States, remains in immediate charge of the work. Stations have been maintained continuously, since my last annual report, at the following places: — Macon, on the Ocmulgee river; Oakdale and West Point, on the Chattahoochee; Carter's, on the Coosawattee; Canton, on the Etowah; Dublin, on the Oconee; Carlton, on the Broad; Madison's Ferry, on the Tugalo; Augusta, on the Savannah; and Albany, on the Flint. The station at Resaca, from the cost of which this Survey was relieved by the U. S. Weather Bureau Nov. 1st, 1898, was temporarily discontinued by the Bureau, April 30th, 1899, to be resumed again Nov. 1st. A station on the Coosa river at Rome was established by the Weather Bureau, Nov. 1st, 1898, for observation during the winter months; and the daily gauge-heights were furnished by the Weather Bureau, for the joint work of the two Surveys, till May 1st. From that date, Mr. W. M. Towers, Observer for the Weather Bureau, during its season, has generously performed this duty for the Survey, *gratis*, until the work should be resumed by the Weather Bureau, Nov. 1st, 1899. The old station at the Seaboard Air-Line bridge, over the Savannah river, was re-established March 4th, by the Weather Bureau; and Mr. Hall has been furnished the daily gauge-heights, for the joint work, regularly since that time. A station was established near Blue Ridge, on the Toccoa river, Nov. 25th, 1898, with Mr. J. L. Seabolt as gauge observer. His death occurring shortly after, he was succeeded by Mr. H. M. Seabolt, who in turn, was succeeded Oct. 1st, by Mr. M. V. Presley, the present observer. The abandoned station at Almon, on the Yellow river, was re-established May 9th, by the Weather Bureau, which has regularly, since, furnished the Surveys with the daily gauge-heights.

Mr. Hall and his assistants, Messrs. Max Hall and J. C. Conn,

have measured, with the best current-meters, the velocities of all the streams, mentioned above, at the several stations and at various stages of the water, during each season of the year. The important work of locating and mapping such falls and shoals, as did not appear on the map published in our first bulletin on the Water-powers, I have not been able to take up, because of the insufficiency of the appropriation to do this, and, at the same time, meet the necessary expenses of the work already, in hand.

PERSONNEL OF THE SURVEY

Mr. S. W. McCallie and Dr. Thomas L. Watson, Assistant Geologists, continue in the service of the Survey. Mr. F. E. Ellis, who had been clerk to the State Geologist, for something over four years, tendered his resignation, the latter part of May, in order to accept a position, which gave promise of greater remuneration. Mr. W. H. Anthony, of Greenville, who was appointed to fill the vacancy, resigned the position, July 16th; and, after two temporary appointments, Mr. W. C. Davis, of Eatonton, was appointed to the position, beginning work Oct. 1st.

The watchman for the State Museum resigned his position the first of January; and, for lack of sufficient funds, none has been employed, since. A janitor has been employed, during the year, at a trifling sum, to keep the cases, tables and large specimens free from dust.

The collecting of data, for the next report on the Water-powers, has necessitated the employment of several gauge-observers, which has been done, at a small cost to the Survey. In addition to these,

the names of those, who have generously furnished the necessary service to the Surveys *gratis*, and the names of the agents of organizations, furnishing such service, are given as follows:—

Observer	Station	River
H. S. Weems	Carter's	Coosawattee
W. T. Bass	Macon	Ocmulgee
T. S. Collins		
C. H. Turner	Oakdale (Lower Gauge)	Chattahoochee
J. H. Lowry	" "	"
C. E. Melton	West Point	Chattahoochee
M. F. Echols		
S. M. Barnett	Resaca	Oostanaula
S. C. Cobb	Madison's Ferry	Tugalo
P. J. Pfeiffer	S. A. L. Bridge	Savannah
J. M. Youngblood	Augusta	"
John E. Clark	Albany	Flint
J. L. Seabolt ¹	Blue Ridge	Toccoa
H. M. Seabolt		
Otha E. Tucker	Almon	Yellow
W. M. Towers	Rome	Coosa
James A. Low	Canton	Etowah
Mathew R. Scarborough	Dublin	Oconee
S. P. Power, Jr.	Carlton	Broad

During the year, this Survey was relieved, by courtesy of the U. S. Weather Bureau, of the expense of maintaining certain stations, as follows:— Macon, from June 21st; Oakdale (Lower Gauge), from June 1st, the former station at Oakdale having been substituted for it; West Point and Carlton, from March 1st; the

¹ Deceased.

Seaboard Air-Line Bridge, from March 4th, when the station was re-established; Dublin and Albany, for the entire year; and Rome, Resaca and Canton, half-year stations of the Weather Bureau, from Nov. 1st, 1898 to May 1st, 1899. These half-year stations are to be resumed by the Weather Bureau, Nov. 1st, 1899. The one at Rome has been continued by Mr. W. M. Towers, Weather Bureau Observer, *gratis*, since April 30th, as stated in another place; and the State Survey has paid for the service at Canton, since that date; but the station at Resaca has remained unoccupied, since it was temporarily discontinued by the Weather Bureau. A new station was established, by this Survey, Nov. 25th, 1898, at a point on the Toccoa river, three miles from the town of Blue Ridge in Fannin county, Sunday observations being omitted, because of the non-residence of the observer. The station at Almon, on the Yellow river, was re-established May 9th, by the U. S. Geological Survey, at a point, one mile above the old station, the Georgia Survey assuming the expense of it, July 1st.

This Survey gratefully acknowledges its obligations to Mr. H. S. Weems, for gratuitous service, in reporting the daily gauge-heights at Carter's station, during the entire year; and the City of Augusta, for like service at Augusta; also, to Mr. W. M. Towers, for similar service at Rome, since April 30th, and to the U. S. Weather Bureau, for its generous aid, in furnishing data from the several stations, as above indicated. All other observers, employed by this Survey, were paid a small amount for their services.

EQUIPMENT

I have not found it necessary to add a great deal to the Survey's equipment, during the year just ended. The only items of consequence are a pair of horses, 1 $\frac{1}{4}$ doz. hammers, 1 book-case, 1 60-gramme platinum crucible, 1 30-gramme platinum Gooch crucible, and 1 cut Amethyst from Rabun county, set as a ring (for the State Museum).

The library continues to grow. It has been increased, during the year, by 93 books and pamphlets, making a total of 510. Most of these have been received in exchange for our own reports.

REPORTS

Since my last administrative report, two economic reports have issued from the press, as follows : — Bulletin No. 6 – A, A preliminary Report on a Part of the Clays of Georgia, and Bulletin No. 7, A preliminary Report on the Artesian-Well System of Georgia. These are now being distributed. A report on the Roads and Road-building Materials of Georgia is now ready for the press, to be published as Bulletin No. 8. The field-work and most of the laboratory-work, on a large part of the Granites and Gneisses of the State, have been completed ; and a report on this subject will soon be turned over to me by Dr. Watson, for publication. As soon as possible, field-work will be resumed on this important subject, for data for the publication of the second and last bulletin on the Granites and Gneisses of the State.

WORK PLANNED

According to my plans, as stated in my last administrative report, work should have been resumed on the survey of the Phosphates and Marls of the State, the first of last March; but Assistant Geologist McCallie, who was, at that time, the only member of the Survey available for this work, failed to complete his report on the Roads and Road-building Materials of the State, in time to do the work on the Phosphates and Marls. I trust that the condition of the Survey's limited appropriation will be such, as to permit me to start him on this work, the first of next March. Later on, he will resume his survey of the Iron Ores, which will be steadily prosecuted, for the remainder of the season. Dr. Watson, when his services are not required in the laboratory as Chemist, will continue field-work on the Manganese deposits. The out-door work, laid out for myself for next season, contemplates a number of visits to different parts of the State, so that I may be the better able to plan the future work on systematic economic surveys, and to make preparations for beginning the areal geological survey of the State, in which the entire area of each county will be surveyed, to be accompanied with county maps, showing all the elevations and depressions of any consequence, all streams, all public roads, with the cities, towns, villages, country stores, churches and school-houses accurately located along them, and the economic minerals and the geology of the county, indicated by colors and special devices. In addition to these trips, I will be occupied, a large part of the time, with the further survey of the gold deposits.

STATE MUSEUM

During the year, 203 specimens have been catalogued and added to the Museum collections, some by gift and others, by collection in the field by myself and my assistants.

Last catalogue entry for the year ending Oct. 15, 1899 . . . 1,788

Last catalogue entry for the year ending Oct. 15, 1898 . . . 1,691

Some good material, for cutting and polishing as semi-precious stones, has been obtained ; and I have laid aside a number of good specimens of this, for preparation, as additions to our gem collection. I trust, that by thus bringing these to the attention of the public, industries may spring up, for the manufacture of this valuable material for the trade. A very handsome suite of beautiful barite crystals, I secured at the Lindermann Ocher Mine, as a gift from Mr. S. S. Staples, of Cartersville. The crystals, occurring in this mine, are remarkable for their beauty and their abundance.

Last year, I called attention in my administrative report, to the great necessity for suitable cases, in which to display the valuable collection of ores and other economic minerals and mineral products, which were then, and are now, at the mercy of the vandals, who, from time to time, pass through the State Museum. I again call attention to the urgent need of cases, to protect this part of the Museum.

This State has abundant mineral resources, of the best class, which should be displayed in a Museum Building, adapted to the requirements of such a display ; and, if such a building, properly equipped were available, I could easily fill it with exhibits of

such character, as would give the State wide reputation for its remarkable resources, and would bring millions of dollars for investment within her borders.

All during my administration, I have planned to create a section of the State Museum, that would fully illustrate the economic geology of the State, in variety of material and in geographic distribution, as shown by the various bulletins we have, and are now issuing; but I have been so hampered, by lack of funds, that I have been able to carry out this idea but poorly. As I said, in a former report, \$8,000 a year, with \$5,000 of it, reserved by statute for the salaries of the three geologists, is not adequate to do the work, that we should do, for the upbuilding of this great State. In this day it goes without saying, that a well-equipped and well-maintained State Museum, is the very best means of impressing the world at large with the commercial importance of a State and its possibilities, when developed; but, be a State ever so rich in its resources, its commercial progress must be slow, unless judicious exploiting is taken advantage of.

ACKNOWLEDGMENTS

The following gifts have been received from friends of the Geological Survey, and have been catalogued as follows:—

MR. E. P. PRICE, NANNIE, GA.

Two specimens of Manganese Ore, from Floyd county.

MR. J. V. ROBINSON, LOST MOUNTAIN, GA.

One specimen of Garnet in Hornblende-schist, from Cobb county.

MR. T. S. ARTHUR, ATLANTA, GA.

One specimen of Graphite in Decomposed Mica-schist, from Madison county.

MAJ. JAMES M. COUPER, ATLANTA, GA.

One specimen of Granular Silica, from near Ellijay, Gilmer county.

MR. F. A. SINQUEFIELD, BLUE RIDGE, GA.

One specimen of Garnet Crystals, from the Sinquefield Lot, Fannin county.

JUDGE COLUMBUS HEARD, SILOAM, GA.

One specimen of Potstone, from Boswell's property, Greene county.

MR. CHAS. ROBERTS, NACOOCHEE, GA.

One specimen of Indian Relic — Discoidal Stone, from the Tripp property, Lot 25, 3rd Dist., White county.

One specimen of Indian Skin-Dresser, from the Trammel Place, Nacoochee Valley, White county.

One specimen of Indian Relic, from the Trammel Place, White county.

One specimen of Garnet Crystal, from Union county.

DR. J. C. HARRIS, SUWANEE, GA.

One specimen of Auriferous Quartz, showing Free Gold, from near Suwanee, Gwinnett county.

One specimen of Indian Pipe, from Dr. E. D. Little's farm, near Sheltonville, Forsyth county.

MR. E. J. HOUSTON, SAUTEE, GA.

One specimen of Asbestos, from E. J. Houston's farm, near Nacoochee, White county.

MR. T. J. CARR, MAYSVILLE, GA.

One specimen of Epidote, from T. J. Carr's farm, 1 mile from Maysville, Banks county.

MR. C. M. BINFORD, ATLANTA, GA.

One specimen of Fuller's Earth, from Decatur county.

DR. E. D. LITTLE, SUWANEE, GA.

- Four specimens of Amethyst, from near Sheltonville, Forsyth county.
- Three specimens of Quartz Crystals, from near Sheltonville, Forsyth county.
- One specimen of Rock Crystal from near Sheltonville, Forsyth county.
- One specimen of Roasted Pyritiferous Gold Ore, showing Free Gold, from E. D. Little's Mine, Forsyth county.
- One specimen of Tourmaline Crystal, containing a Core of Quartz, from near Sheltonville, Forsyth county.
- Three specimens of Corundum, from near Monroe, Walton county.
- One specimen of Chalcedony, from near Monroe, Walton county.
- One specimen of Indian Stone Disc, from Forsyth county.
- Two specimens of Indian Relics — Skin-Scrapers, Sheltonville, Forsyth county.
- One specimen of Indian Relic — Spear-head of Quartz, Sheltonville, Forsyth county.
- One specimen of Indian Relic — Quartz Disc, Sheltonville, Forsyth county.
- One specimen of Indian Relic — Sinker of Hematite, Sheltonville, Forsyth county.
- Two specimens of Indian Relics of Potstone, Sheltonville, Forsyth county.

MR. E. M. BROWN, EATONTON, GA.

- One specimen of Unidentified Mineral, from Putnam county.

MR. D. J. DUNCAN, CLAYTON, GA.

- One specimen of Quartz Crystal with Inclusions of Hematite Crystals and Rutile, from Rabun county.
- Sixteen specimens of Amethyst Crystals, from the Ledbetter Mine, Rabun county.
- One specimen of Beryl, from the Ledbetter Mine, Rabun county.

MR. J. A. REYNOLDS, CLAYTON, GA.

- One specimen of Quartz Crystal with Inclusions of Hematite, from Rabun county.
- Four specimens of Rose Quartz, from Rabun county.
- One specimen of Quartz Crystals, from Rabun county.
- One specimen of Garnet, Partly Decomposed, from Rabun county.
- One specimen of Rutilated Quartz, from Rabun county.

MR. E. D. KINSEY, CLARKESVILLE, GA.

One specimen of Ruby Corundum, from Habersham county.

MR. JOHN M. YORK, PERSIMMON, GA.

One specimen of Indian Arrow-head of Pink Quartz, from Rabun county.

MR. R. K. REAVES, ATHENS, GA.

Two specimens of Pyrite in Hornblende-schist, from Rabun county.

MR. W. W. LINCH, EATONTON, GA.

Two specimens of Blue Granite, from Putnam county.

MR. R. P. BEECHER, MARBLE HILL, GA.

One specimen of Stalagmite, from Marble Hill, Pickens county.

Thirteen specimens of Stalactite, from Marble Hill, Pickens county.

MR. CHAS. RAGNAN, LULA, GA.

One specimen of Rock Crystal Indian Arrow-head, from Hall county..

MR. R. W. WOODARD, GRIFFIN, GA.

One specimen of Opalescent Quartz, from near Griffin.

JUDGE J. S. TURNER, EATONTON, GA.

Two specimens of Jasper with Quartz, from Baldwin county.

MR. GEO. W. SCIPLE, ATLANTA, GA.

One specimen of Agate, from Milton county.

MR. N. Z. GLENN, THOMASTON, GA.

Two specimens of Rock Crystal, from Upson county.

MR. W. S. MADDOX, ATLANTA, GA.

Three Unidentified Specimens, from Fulton county.

MR. W. P. MUNSON, CEDARTOWN, GA.

One specimen of Iridescent Limonite, from Polk county.

MR. I. Y. SAWTELL, ATLANTA, GA.

Two specimens of Molybdenite, from Douglas county.

MR. JOSEPH PHILLIPS, DAHLONEGA, GA.

Three specimens of Arsenopyrite, from the Findley Mine, Dahlonega..

CAPT. F. B. WHITEHEAD, MACON, GA.

- One specimen of Rock Crystal, from Round Oak, Jones county.
- One specimen of Magnetite, from Round Oak, Jones county.
- One specimen of Garnet Crystal, from Round Oak, Jones county.
- One specimen of Ilmenite, from Round Oak, Jones county.
- One specimen of Jasper, from Round Oak, Jones county.
- One specimen of Agate, from Round Oak, Jones county.

MR. JAMES GLEN, SAUTEE, GA.

- One specimen of Gold Ore (Auriferous Chalcopyrite in Quartz), from White county.

MR. J. R. BARBER, CEDARTOWN, GA.

- One specimen of Iridescent Limonite, from Polk county.

AWARDS AT THE TRANS-MISSISSIPPI AND INTERNATIONAL EXPOSITION

As at the Tennessee Centennial Exposition, so at the Trans-Mississippi and International Exposition, held at Omaha last fall, Georgia lead the other States, in the display of Minerals, Ores, Building Stones, Fruits etc. In announcing the list of awards, the *Omaha Bee* placed conspicuously in the heading to the announcement: — “*Georgia Leads, While Other States Come Trailing Behind.*” The awards of 9 gold medals, 1 silver medal and 5 bronze medals, with diplomas of merit, were made as follows: —

GOLD MEDALS

- 1 To “W. J. NORTHEN, Vice-President, *for Valuable Services Rendered.*”
- 2 For “*Building Stones, Marbles, Granites Etc.*”

- 3 For "*Aluminum Ores and Products.*"
- 4 For "*Ornamental Lumber and Timber Specimens.*"
- 5 For "*Collection of Fruits.*"
- 6 For "*Agricultural Exhibits.*"
- 7 For "*Display of Cotton-seed and Wool Products.*"
- 8 To "JOHN A. MANGETT, for 171 Products from 25-Acre Farm in Georgia."
- 9 For "*Collective Exhibits.*"

SILVER MEDAL

- 10 For "*Corundum, Mica, Graphite and Asbestos.*"

BRONZE MEDALS

- 11 For "*Gold Ores.*"
- 12 For "*Iron and Manganese.*"
- 13 For "*Clays, Kaolins Etc.*"
- 14 For "*Sugar Cane and Syrup, Superior Quality.*"
- 15 For "*Indian Corn, Factory Cheese and Timber Specimens.*"

The Commission in charge of the Georgia exhibits, with Ex-Governor W. J. Northen as its Chairman, turned over to Your Excellency 9 gold-plated bronze medals, 1 silver medal and 5 bronze medals, which were placed by you in my care for exhibition. These can now be seen, in our special gold-and-gem case, in the east corridor, second-floor of the Capitol.

Too much credit cannot be given to Governor Northen and his fellow-members of the Commission, for their untiring efforts, made at great personal discomfort and, at times, under circumstances, most embarrassing, to secure the necessary funds, that made this display of the State's magnificent resources possible. By the

active energy of such noble citizens, Georgia must eventually take her proper position before the commercial world.

GEORGIA STATE FAIR

At the solicitation of Ex-Governor W. J. Northen, Chairman of the Local Committee, Georgia State Fair, to be held at the Exposition Grounds, Oct. 18th–Nov. 4th, 1899, inclusive, I was directed by the Advisory Board, at one of its meetings, some time ago, to make an exhibit of the Collections of the State Museum at the Fair, the Fair authorities to pay all expenses, incurred in making the exhibit. Very choice space, in the Agricultural building, has been assigned me for this purpose; and I am now actively engaged in getting this exhibit installed.

APPROPRIATIONS

At the last session of the General Assembly, the appropriation of \$8,000 per annum for the years 1899 and 1900, was made for the maintenance of the Geological Survey, conditional on the report of a Joint Committee of the House and Senate, to investigate the Survey; but no provision was made for printing the reports of the State Geologist. The report on the Roads and Road-building Materials of the State, a bulletin of about 350 pages is now ready for the press; but we are without funds, with

which to print and publish it. The report on the Granites and Gneisses of 26 counties in Georgia will be ready for the press, by the latter part of next spring ; but there are no funds available for its publication. I respectfully call the attention of the General Assembly to the urgent necessity of publishing these valuable economic reports, in order that the public at large may be informed of these resources of the State, thereby inducing investment and development.

ACKNOWLEDGMENT TO THE ADVISORY BOARD

In conclusion, I wish to gratefully acknowledge the cordial relations existing between the Advisory Board and myself, and to express my keen appreciation for their generous aid, in bringing to successful issue the work of the Geological Survey.

GEOLOGICAL SURVEY OF GEORGIA

W. S. YEATES, State Geologist

ADMINISTRATIVE REPORT

OF THE

STATE GEOLOGIST

For the Year Ending

October 15th, 1900

ATLANTA, GA.

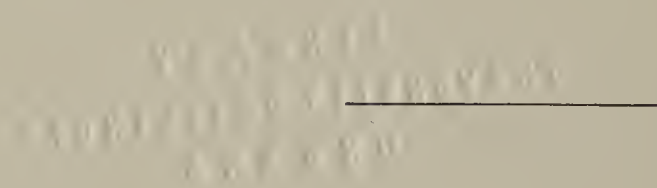
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THE ADVISORY BOARD
of the
Geological Survey of Georgia



(Ex-Officio)

HIS EXCELLENCY, A. D. CANDLER, Governor of Georgia

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ADMINISTRATIVE REPORT

GEOLOGICAL SURVEY OF GEORGIA,
ATLANTA, October 16th, 1900.

*To His Excellency, A. D. CANDLER, Governor, and President of
the Advisory Board of the Geological Survey of Georgia,*

SIR : — I have the honor to submit to you my administrative report, for the year ending October 15th, 1900.

The administrative work of my office has demanded the most of my time, during the year just ended, much of it consisting of answering a large number of letters, which have been addressed to me by persons, seeking information as to the mineral resources of the State; while no small portion of it has been given to visitors to my office, seeking such information in person. Many capitalists and agents with capital for investment, have thus sought information from this office; and I have furnished it, as freely as I have been able, except in such cases as the law contemplates, in prohibiting the State Geologist and his Assistants from disclosing to any one, except the owner of the property, the result of a survey, in advance of publication.

As it is the policy of the Survey to issue very comprehensive monograph reports, on each subject embraced in the economic geology of the State, and as much time is required for collecting and preparing such detailed information for publication, I have instituted a series of card-catalogues, in which is entered, and kept,

Georgia - Gov. Candler - 1900

easy of access, general and, to some extent, specific information, on every subject of our economic geology and timber resources, as fast as it can be gathered.

Such information is now being catalogued, under the name of each subject, and cross-catalogued, under the name of the county, in which the material occurs. Much valuable information for this work has already accumulated; and it is my intention to devote much of the time, that I may be able to spend in field-work, during the coming year, to gathering further data for this purpose. I am also keeping, in one of this series of catalogues, the names and addresses of all persons in the State, known to me to have mineral properties for sale, and a brief description of such property; and, on a corresponding card-catalogue, the name and addresses of such persons, as indicate to me, that they desire to invest in mineral or timber properties in the State, are kept. The former of these, I find it necessary to keep, in order to furnish information to hundreds of investors, who are constantly applying to me, to know, if I can inform them, where they may procure particular kinds of mineral and timber properties in this State; the latter, because, from time to time, our own citizens write me, to find them a buyer for certain kinds of mineral properties, they wish to dispose of. I have been able to furnish considerable information of this kind, in the past, and I have reason to believe, with good results to the State; but, with the information at hand, and systematized, the desiderata can be furnished much more expeditiously, and with a great saving, in time and labor.

Much of my time, during the year, has been given to editing and otherwise preparing two reports for the press. One of these, on the Iron Ores of Polk, Bartow and Floyd counties, I have com-

pletely edited, and it is now going through the press; while the other, on a Part of the Granites and Gneisses of Georgia, I am now editing, with the work well under way. The first of these will make a bulletin of about 160 pages; the other, one, of about 500 pages.

In field-work, I have made a number of special trips to different parts of the State, in addition to my systematic work on a survey of the gold deposits in those counties, not included in our first bulletin on this subject. So far, this season, my systematic field-work has been confined to Coweta, Meriwether and McDuffie counties. Of the special trips, made, two involved surveys of properties, which promise investment of considerable foreign capital in the State, in the near future.

Our citizens in various parts of Georgia continue to apply to me, for the identification of minerals, ores and rocks, of which they wish to know the nature and value. Many of these are brought to my office; while many are sent to me, by mail and express. Of such material, I have examined and reported on 987 minerals, rocks and ores, during the year, giving my opinion, as to their commercial value, in almost all cases.

WORK OF THE ASSISTANT GEOLOGISTS

After the date of my last annual report, Mr. McCallie continued the survey of the Iron ores, during the remainder of the field-season of 1899; and, during the winter and much of the following spring, he was engaged in working up and writing his report, from the data secured in the field. It was not originally intended

to bring out a bulletin, on so small an amount of field-work accomplished; but the price of iron having greatly increased in the market, and the demand for the information in our possession having been considerably augmented thereby, it seemed best in this particular instance, to publish a small bulletin, rather than wait, till sufficient territory had been surveyed, to issue a thicker volume. The preparation of this required some supplemental field-work, which Mr. McCallie did, last spring.

His report on the Iron Ores of Polk, Bartow and Floyd counties was completed, and turned over to me, the latter part of June, when he resumed field-work on the iron ores, beginning in Dade county. He has finished a survey of these ores and the coal deposits of this county, and has nearly completed the same subjects in Walker county. On account of the rugged, mountainous character of Dade county, the progress of the work has been necessarily slow, much of it having to be done, on foot.

From the date of my last administrative report, Dr. Watson was occupied in the chemical laboratory and in office work, preparing his very extensive report on the greater part of the Granites and Gneisses of the State. During the year, he made 17 complete chemical analyses of samples of granites and gneisses, collected by him, during his field-work. These, with the analyses made during the year, immediately preceding, make a total of 76 complete analyses of the granites and gneisses of Georgia, which are included in this valuable economic report. In addition to the analyses mentioned, a partial quantitative analysis of a limestone was made, looking to the location of a large plant in the State, for the manufacture of Portland cement; and numerous physical tests, such as determining the specific gravities, the ratios of absorption etc., of most of the granites and gneisses studied, were made in the laboratory of the Survey, by Dr. Watson. A

part of the remaining preparatory work, for this report, was the critical examination and study of 180 thin sections of these rocks. After this and other necessary work, Dr. Watson was engaged in writing and revising this report, until Sept. 10th, when he repaired to the field, to resume his work on the Manganese deposits of the State. Since then, he has been engaged on a survey of these deposits in Bartow county, where, from a verbal report to me, he has found this ore to exist in large quantities, and of excellent quality, far surpassing his expectations. He estimates, that, with his best efforts, a survey of these and the Yellow Ochre deposits, in the same county, to which work I also assigned him, will require not less than two months.

FIELD-WORK ON THE WATER-POWERS

The co-operative field-work on the Water-Powers of Georgia, which has been maintained by this Survey and the U. S. Geological Survey, during the past five years, continues, with increasing advantage to the State.

Prof. B. M. Hall, Hydrographer of the U. S. Geological Survey for the States of Georgia, Florida, Alabama and Tennessee, remains in immediate charge of the work. For several years, I have been anxious to have the rivers of the State meandered and profiled, from the fall-line up to the last shoal, available for water-power, in order to accurately locate and map a considerable number of valuable shoals, not hitherto correctly located, and many of them, not shown on any map. But for lack of sufficient appropriation, and because of more urgent demands, along other lines

of our economic geology, I found it impossible to take up this very desirable work. Finally, I laid the matter, before the Director and the Chief Hydrographer of the U. S. Geological Survey, in person, the early part of last spring, and requested them to take up this, as a part of our co-operative work. The proposition was favorably received, and Prof. Hall was instructed to put parties in the field, and to start the work at once.

In accordance with these instructions, three parties were sent to the field. A continuous line of levels was run down the Ocmulgee river, from Constitution, a small town seven miles below Atlanta, to Macon, a distance of about 105 miles; on the Coosawattee river, a line of levels was run, up the stream, from Carter's to Ellijay, a distance of 24 miles; and, on the Flint river, a line of levels was run down the river, for about 50 miles, beginning at Woodbury, Meriwether county. In all three of these surveys, all necessary measurements were made, and lot-lines and other permanent objects, that would be of assistance, in making accurate maps, and locating shoals, mills etc., were noted.

Since my last annual report, gauge-stations have been maintained continuously, at the following points:—Madison Ferry, on the Tugalo river; the S. A. L. Bridge and Augusta, on the Savannah; Carlton, on the Broad; Dublin, on the Oconee; Almon, on the Yellow; Macon, on the Ocmulgee; Albany, on the Flint; Oakdale and West Point, on the Chattahoochee; Canton, on the Etowah; and Rome, on the Coosa. All these are old stations, referred to, in my last annual report. A new station was established by this Survey, on the Towaliga river, near Juliette, Nov. 2nd, 1899, and has been maintained ever since. A new station was also established by the Geological Survey of Georgia, at Woodbury, on the Flint river, Mar. 29th, 1900, since which,

weekly reports have been regularly received. Another new station was established by this Survey, at Tallulah Falls, on the Tallulah river, Aug. 29th, 1900; and it has since been continuously maintained.

During the year, the Surveys have been furnished regularly, by courtesy of the U. S. WEATHER BUREAU, weekly reports of the daily gauge-heights of streams, at the following stations:—The S. A. L. Bridge, over the Savannah river; Carlton, on the Broad; Dublin, on the Oconee; Macon, on the Ocmulgee; Albany, on the Flint; and Oakdale and West Point, on the Chattahoochee; also, from Nov. 1st, 1899, to April 30th, 1900, the daily gauge-heights at Resaca, on the Oostanaula river; Rome, on the Coosa; and Canton, on the Etowah. The expense of the station at Resaca was assumed by the Geological Survey of Georgia, May 1st; but, since June 30th, no reports have been received, and Prof. Hall, Hydrographer-in-charge, has not thought best, so far, to re-establish the station. From Oct. 16th to Oct. 31st, 1899, inclusive, and from May 1st, 1900, to the present time, Mr. W. M. Towers, U. S. Weather Bureau Observer, has generously furnished the Surveys with the daily gauge-heights, at the Rome station, on the Coosa river, *gratis*; and similar service was rendered, by Mr. H. S. Weems, at Carter's, on the Coosawattee, from Oct. 16th, 1899, to Aug. 25th, 1900, when he discontinued sending the reports. The expense of the station at Canton, during the year, has been borne by this Survey, except for the six months, it was occupied by the Weather Bureau. It has been difficult to man the station, on the Toccoa river, near Blue Ridge, on account of its remoteness from any habitation. Consequently, two gaps, of considerable size, in the records of the gauge-heights at this station, have occurred, because of the deser-

tion of the work by gauge-observers. This Survey has maintained the station from Oct. 16th to Dec. 23rd, 1899; from Mar. 23rd to May 19th, 1900; and from June 27th, 1900, to date. In addition to the stations already mentioned, as having been wholly, or in part, maintained by the Geological Survey of Georgia, it has borne the expense, during the entire year, of the stations at Madison Ferry, on the Savannah, and Almon, on the Yellow river. The City of Augusta has kindly furnished, *gratis*, the daily gauge-heights of the Savannah river at Augusta.

For the gratuitous service, rendered by MR. W. M. TOWERS and MR. H. S. WEEMS, and by the U. S. WEATHER BUREAU and the CITY OF AUGUSTA, the Geological Survey of Georgia is profoundly grateful.

On the topographic work, done at the expense of the U. S. Geological Survey, referred to on page 8, Messrs. D. L. Wardroper, Olin Hall, K. T. Thomas and J. C. Conn were, for some time, engaged. While this work has been temporarily stopped, it is intended to start it up again, soon, and push it to completion.

During the year, Prof. Hall and his assistants, Mr. Max Hall and others, have made the necessary discharge measurements of the streams, at all the stations, at various stages of the water, during each season of the year, using the best current-meters. Three horse-back trips have been made, through North Georgia by a party of two men, in which more than 100 discharge measurements were made, on the tributaries of the Coosawattee, the Etowah, the Chestatee, the Chattahoochee, the Soquee, the Hiawassee and the Toccoa (Ocoee) rivers, covering practically the entire water-sheds of these rivers, above Carter's, Canton and Gainesville, and south of the Tennessee line.

PERSONNEL OF THE SURVEY

Mr. S. W. McCallie and Dr. Thomas L. Watson, Assistant Geologists, continue their connection with the Survey. On the 15th of September, Mr. W. C. Davis, Clerk to the State Geologist, tendered his resignation, in order to go into private business. Mr. A. S. Johnston, of Atlanta, was appointed to the position, beginning work, September 26th. A janitor is employed, at a small sum, to keep the cases, the tables and the large exposed specimens, free from dust.

Several gauge-observers have been employed, at a small cost to this Survey, during the year. The names of these, together with those who have generously rendered service to the Surveys, *gratis*, and the names of the agents of organizations furnishing such free service, are as follows :—

Observer	Station	River
H. S. Weems	Carter's	Coosawattee
W. M. Towers	Rome	Coosa
S. M. Barnett } T. G. Fain }	Resaca	Oostanaula
Jas. A. Low	Canton	Etowah
M. V. Presley } W. E. Rogers }	Blue Ridge	Toccoa (Ocoee)
J. H. Lowry	Oakdale	Chattahoochee
M. F. Echols } C. P. Jennings } C. E. Melton }	West Point	"
J. C. Wright	Woodbury	Flint
John E. Clark	Albany	"

Observer	Station	River
Thomas Pittman } W. L. Jackson }	Juliette	Towaliga
Otha E. Tucker	Almon	Yellow
T. S. Collins	Macon	Ocmulgee
M. R. Scarborough	Dublin	Oconee
T. A. Robinson	Tallulah Falls	Tallulah
S. P. Power, Jr.	Carlton	Broad
S. C. Cobb	Madison Ferry	Tugalo
P. J. Pfeiffer	S. A. L. Bridge	Savannah
J. M. Youngblood	Augusta	"

EQUIPMENT

At the close of the field-season, last year, the pair of horses, which had been purchased for field-service, was sold, and the money, resulting from the sale, was restored to the Geological fund, as recorded on the minutes of the Advisory Board. With the exception of ordinary stationery and other minor supplies, the only items, added to the equipment of the Survey, were 1 new Smith-Premier typewriter, in exchange for an old one; 1 6-drawer oak card-catalogue case; 1 4-drawer oak letter-press stand, 1 file-case for the distribution of reports, 3 pocket compasses, 1 contact goniometer, 1 Dausacme duplicator, $\frac{1}{2}$ doz. geologist's hammers and 1 tool-chest.

The library has been increased by 148 books and pamphlets, making a total of 658, to date. A few of these have been pur-

chased as a part of the equipment, necessary for the work of the Survey ; but most of them have come as contributions to the Survey library, or have been received in exchange for our own publications.

REPORTS

On account of the failure of the last Legislature to provide for the printing of the reports of the State Geologist, two valuable reports remain in my hands unpublished. One of these, a report on the Roads and Road-building Materials of Georgia, to be published as Bulletin No. 8, of not less than 350 pages, has been ready for the press, for more than a year. The other, a report on the most important deposits of the Granites and Gneisses in the State, to be published as Bulletin No. 9-A, of about 500 pages, is completed, and can be sent to press, on short notice.

Over and above the requirements for the ordinary expenses of the Survey, there has been some accumulation of its funds, with which I had hoped to have built some much needed cases, for exhibition of the State's resources in the Museum ; but, on account of the great demand for our report on the Iron Ores of Polk, Bartow and Floyd counties, it seemed absolutely necessary, that we use these funds for printing, illustrating and binding an edition of 3,000 copies of this report. Accordingly, with the consent of the Advisory Board, I sent the report to press, Oct. 5th, to issue in 60 days.

Field-work has been completed for a detailed report on the Aluminum deposits of Georgia ; and, during the coming winter, the necessary laboratory and other work of preparation will be fin-

ished; and I anticipate, that a report will be ready for the press, not later than spring. Since our report on a part of the water-powers of the State was published in 1897, considerable data have accumulated, which will enable us to publish another bulletin on this subject, before long; and it is my intention to have a report prepared for the press, as soon as the work of meandering and profiling the various stream-systems shall have been completed. This, I trust, will be before the re-convening of the Legislature in its second session. With this report, I intend to issue a much larger and better map of the stream-systems of the State; and the character of the information, we are now collecting, is such, as to enable us to more fully and accurately locate, on such a map, all the valuable water-powers of the State, a thing we were able to do, in Bulletin No. 3-A, in a limited way only, on account of the urgent demands for information on the subject, at that time, and the consequent necessity of publishing a report, compiled, for the most part, from the work of an assistant of my predecessor, and other available sources, at hand. Much of this information was valuable; but it left much to be done, before an accurate map of the water-powers of the State could be brought out.

On account of the difficulties encountered in the field-work,¹ it is not likely, that enough data will have been collected, to justify the publication of another report on the Iron Ores of the State, before next October; but, during the winter months, the laboratory and office work, necessary to put it in report form, will be done.

While considerable material, for a report on the Manganese deposits, will have been collected, by the close of the field-season; still, it is hardly probable, that there will be enough, to warrant

¹ See page 6.

the issuing of a bulletin on this subject, during the next year. It is highly desirable, to comprise each economic subject in a single volume, wherever the amount of material involved will admit of it. The volume issued should be of such size, that it may be conveniently handled, and, at the same time, present a neat appearance — neither too bulky nor too small. For this reason, it may be necessary, soon, for us to depart, in one or two instances, from the monograph bulletin, and to include several subjects in a single bulletin, classifying them, however, as far as possible.

Because the Administrative duties of my office have demanded so much of my time, during the past two years, I have not been able to accumulate sufficient data, to issue another bulletin on the Gold deposits, as yet; but I trust, that I may be permitted to devote more of my time to this subject, during the next field-season.

It is to be hoped, that the Legislature, at its approaching session, will provide for the publication of the three bulletins, which are now, or will be, ready for the printer, before it re-convenes next fall, and that similar provision will be made for the publication of the reports, which will be prepared during the following year, of which I may reasonably mention a second report on the Water-Powers (Bulletin No. 3-B); a second report on the Gold Deposits (Bulletin No. 4-B); a second report on the Iron Ores (Bulletin No. 10-B); and a report on the Manganese Deposits (Bulletin No. 12).

There has been large demand for the reports of the Geological Survey, during the year just ended, most of the applicants being capitalists, or those trying to interest capital in the development and profitable working of the various mineral deposits of our State. In all, I have distributed 2,480 of these economic bulletins, since Oct. 15th, 1899.

WORK PLANNED

The field-work, contemplated for the coming year, will include a continuation of the surveys of the Iron Ore, Gold and Manganese deposits, and the economic examination of the Water-Powers of the State. I regret, that, on account of the urgent demands for the Iron Ore report, Mr. McCallie was not able to resume his work on the Phosphates and Marls, last Spring; but I anticipate, that this will be done next March. I am also anxious to have the survey of the valuable Clay deposits in Middle and South Georgia continued, with a view to bringing out, as soon as possible, a second volume on this subject; but whether we may do so, during the coming year, must depend upon an increase in the annual appropriation for the maintenance of the Survey. In addition to the systematic field-work, I may personally undertake, a number of short trips must be made to various sections of the State, to assist me in laying out further work. Already, I have quite a number of calls, to visit localities, where minerals of economic value are said to abound. The probable abundance and the character of the material must be determined, before systematic surveys can begin.

It is most important, that some attention be given to a survey of the FORESTRY RESOURCES of the State; and I trust, that such provision will be made by the Legislature, as will enable us to do so, during the next year.

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STATE MUSEUM

So little time and money can be spared to building up the State Museum, that additions to it have been comparatively slow ; and, on account of lack of funds, with which to build cases and other devices for exhibiting specimens, we are compelled to pack away, in boxes, in the basement of the State Capitol, much of the material, already collected, hoping to bring it out for exhibition, when the worth of a well-prepared and well-kept State Museum, as a means of illustrating and advertising the material resources of the State, shall be realized more fully. In several of my administrative reports, I have called attention to the fact, that a large number of valuable specimens of woods, building-stones, ores and other economic minerals and mineral products have to be displayed, without cases to protect them from conscienceless vandals, who roam through the corridors of the third floor of the Capitol. Labels are torn from the tables, and other disfigurement marks many of the specimens, the most of which were secured, at considerable cost, through the appropriation for the Cotton States and International Exposition. In again calling attention to this condition, I beg to submit, that funds should be provided to properly encase and protect these valuable collections.

In several of my administrative reports, I have stated, that the corridors of the third floor of the Capitol, are but poorly adapted for use as a State Museum, and that a MUSEUM BUILDING, suitable for exhibiting the natural resources of the State, should be erected. Such an investment would pay the State, many times over.

During the year, 351 specimens have been catalogued and added

to the Museum collections, some, by gift, and others, by collection in the field, by my assistants and myself.

Last catalogue entry for the year ending Oct. 15, 1900 . 1,991

Last catalogue entry for the year ending Oct. 15, 1899 . 1,788

Among the more important accessions to the Museum, during the year, mention may be made of a handsome specimen of Free Gold in Quartz, from the Buffalo mine in Oglethorpe county, the gift of Mr. C. L. Howard, of Stephens, Oglethorpe Co., Ga.; a collection of Beryl crystals, from Chapman's Mica mine, near Hulmeville, Elbert county, the gift of Mr. J. E. Chapman, of Hulmeville, Ga.; 4 slabs and 1 cube of White Marble, from the Southern Marble Quarries, Marble Hill, Ga., the gift of Mr. T. H. Martin, Secretary, Business Men's League, Atlanta, Ga.; a collection of rocks (128 specimens), illustrating a report of the Geological Survey on the Roads and Road-Building Materials of Georgia, collected by Mr. S. W. McCallie, Assistant Geologist; and a collection of rocks (125 specimens, more or less), illustrating a report on a Part of the Granites and Gneisses of Georgia, collected by Dr. Thos. L. Watson, Assistant Geologist.

ACKNOWLEDGMENTS

Gifts to the State Museum have been received from friends of the Geological Survey, and have been catalogued, as follows:—

MR. T. S. ARTHUR, ATLANTA, GA.

One specimen of Corundum in Amphibole; from near Hiawassee, Towns county.

One specimen of Graphite in Decomposed Mica-schist; from six miles south of Royston, Franklin county.

MR. GEORGE H. AUBREY, CARTERSVILLE, GA.

One specimen of Limonite, Pseudomorph after Pyrite ; from near Cartersville.

MR. R. M. AYERS, MARTIN, GA.

One specimen of Kaolin ; from near Martin, Franklin county.

MR. FRANK BARTLETT, WARWICK, GA.

One specimen of Bark of a Cork tree ; from a field near Drayton, Dooly county.

CAPT. J. L. BELL, ATLANTA, GA.

One specimen of Massive Garnet, from Mrs. Eva B. Wilson's farm, seven miles from Atlanta.

HON. W. A. BROUGHTON, MADISON, GA.

Two specimens of Auriferous Chalcopyrite in Quartz ; from the Jett Property, Fulton county.

Two specimens of Auriferous Chalcopyrite with Quartz ; from the Jett Property, Fulton county.

Two specimens of Auriferous Chalcopyrite and Pyrite in Quartz ; from the Jett Property, Fulton county.

MR. JOSEPH E. BROWN, ATLANTA, GA.

One specimen of Talc ; from Cobb county.

MR. J. E. CHAPMAN, HULMEVILLE, GA.

Thirteen Beryl crystals ; from Chapman's Mica Mine, near Hulmeville, Oglethorpe county.

One Quartz crystal ; from Chapman's Mica mine, near Hulmeville, Oglethorpe county.

HON. GEORGE C. DANIEL, DANIELSVILLE, GA.

Four specimens of Limonite ; from John W. Burrough's property, near Danielsville, Madison county.

HON. D. W. HARVARD, UNADILLA, GA.

Three specimens of Limonite (Iron Ore) ; from five miles east of Unadilla, Dooly county.

JUDGE COLUMBUS HEARD, SILOAM, GA.

One specimen of Pot-stone ; from Luther Boswell's property, Greene county.

MR. Z. L. HENRY, CALEB, GA.

One specimen of Quartz ; from Z. L. Henry's property, Gwinnett county.

MR. C. L. HOWARD, STEPHENS, GA.

One specimen of Free Gold in Quartz ; from the Buffalo mine, Oglethorpe county.

MR. E. KIRK, FELTON, GA.

Six specimens of Mica-schist altered to Limonite by infiltration ; from E. Kirk's property, Haralson county.

MR. T. G. LESTER, LEXINGTON, GA.

One specimen of Indian Relic — Stone Disc ; from near Lexington, Oglethorpe county.

MR. C. J. McDONALD, ATLANTA, GA.

Three specimens of Hematite (Iron Ore) ; from the property of C. J. McDonald, near Temple, Haralson county.

MRS. M. E. MEEKS, ATLANTA, GA.

Seven specimens of Gold Ore — Auriferous Pyrite ; from lot 188, 6th district, near Villa Rica, Carroll county.

One specimen of Limonite in Mica-schist, resulting from the oxidation of Pyrite ; from lot 188, 6th district, near Villa Rica, Carroll county.

MR. T. H. MARTIN, SECRETARY, BUSINESS MEN'S LEAGUE, ATLANTA, GA.

Four slabs and one cube of White Marble ; from the Southern Marble quarries, Marble Hill, Pickens county.

MR. C. J. O'FARRELL, ATLANTA, GA.

Two specimens of Limonite ; from near Royston, Franklin county.

MR. W. H. SEARCY, CHERRY LOG, GA.

Three specimens of Pyrrhotite in Massive Quartz ; from W. H. Searcy's property, Cherry Log, Gilmer county.

MR. D. G. SHARKEY, ATLANTA, GA.

One specimen of Dolomite (Magnesian Limestone); from D. G. Sharkey's property, Fulton county.

COL. D. T. SINGLETON, WILLARD, GA.

One specimen of Magnetite ; from Willard, Putnam county.

MR. J. M. SKINNER, ATLANTA, GA.

Two specimens of Pyrite in Quartz ; from the property of G. T. Hurt, near Nickajack, Cobb county.

MR. WILL SOMMER, MACON, GA.

Two specimens of Pottery Clay ; from Will Sommer's property, Lewiston, Wilkinson county.

Two specimens of Clay ; from two miles of Reynolds, Taylor county.

MR. JOHN P. STEGALL, EMERSON, GA.

One specimen of Pyrolusite ; from the John P. Stegall property, near Emerson, Bartow county.

Twenty-five specimens of Yellow Ochre ; from the John P. Stegall property, near Emerson, Bartow county.

MR. J. A. STAFFORD, THE ROCK, GA.

Two specimens of Iron Ore (Limonite); from The Rock, Upson county.

MR. WM. E. SYKES, DELL, GA.

One fragment of Quartz Boulder, showing Free Gold ; from a gravel-bed, five feet below the surface, one mile from the Flint river at Dell, Decatur county.

MRS. T. C. THOMPSON, GAINESVILLE, GA.

Three specimens of Gold Ore (Auriferous Quartz); from lot 205, 2nd district, Douglas county, near Villa Rica.

MR. A. C. TROTMAN, SR., LUMPKIN, GA.

Two specimens of Pyrite ; from the property of A. C. Trotman, Sr., Lumpkin, Stewart county.

HON. J. R. VANBUREN, GRISWOLDVILLE, GA.

Four specimens of Washed Clay ; from the VanBuren property, Griswoldville, Jones county.

Two specimens of Pottery Clay ; from the R. S. Smith property, Wilkinson county.

One specimen of English Ball Clay; from the VanBuren property, Griswoldville, Jones county.

MR. J. T. WILLIAMS, ATLANTA, GA.

Six specimens of Pyrite in Quartz ; from Paulding county.

THE WILKES MINING CO., GRANTVILLE, GA.

One specimen of Free Gold in Quartz ; from the Wilkes Gold mine, Meriwether county.

APPROPRIATIONS

Under this head, I desire to call attention to the fact, that, since the revival of the office of State Geologist, the annual appropriation for the maintenance of the Survey has never exceeded \$8,000. Of this amount, the sum of \$5,000 is set aside by statute, to pay the salaries of the State Geologist and the two Assistant Geologists, leaving the sum of \$3,000 per annum, or \$250 per month, to pay the field, laboratory, office and museum expenses, and for the employment of clerical and unskilled labor, and specialists, when needed.

When one considers the large number of necessary expenses, incident to the work of a Survey, as active as the Georgia Survey

has been, it becomes apparent, at once, that so small a sum is inadequate, if the work is to be done in the most expeditious and economical manner, consistent with the attainment of the best results. There are certain expenses, attaching to an organization of this kind, whether the working force be large or small; and it would be much less expensive to the State, in the long run, if ample provision were made, for the employment of a larger force of geologists and a chemist, so that the work might be done, with the greatest possible expedition, and the State's natural resources be placed before the investor, in such manner, as to attract capital for development and the establishing of permanent industries. With so small an appropriation, the work is necessarily strung out, year after year, when it is clearly to the State's best interests, to have the economic geology completed, as soon as possible. A case in point may be cited, in the survey of the iron ores of Georgia. One of the Assistant Geologists has already spent the best part of the field-seasons of two years, in making a survey of the iron ores of the State; and, in this time, he has not been able to cover half of the territory to be surveyed. Had the force of the Survey been large enough to permit the assignment of three men to this work, at one time, the entire survey of the deposits could, in all probability, have been completed, within two field-seasons, at the outside. Sufficient appropriation for printing, to have enabled us to publish the several reports at once, would have placed the information before the public, with the least possible delay.

The sum of \$15,000 per annum would enable me to employ two additional geologists and a chemist; but the printing of reports would have to be provided for, in addition, either as a separate appropriation, or in the regular appropriation bill for State printing. Many of the Southern and Western States appropriate annu-

ally, from \$20,000 to \$25,000 for the maintenance of a Geological Survey. The State of Maryland makes an annual appropriation of \$20,000, for this purpose, and an additional \$30,000, for a survey of its roads and road-building materials.

In addition to the regular appropriation of \$8,000, for the general expenses of the Geological Survey of Georgia, an appropriation is necessary for the printing, illustrating, binding and publishing of the reports of the Survey. As before stated, failure of the last Legislature to provide for the publication of the reports, now on hand, ready to be sent to the printer, makes some provision necessary for this purpose, at the approaching session. At the rate, paid for publishing Bulletins Nos. 6-A and 7, last year, \$4,000 will be required to print, illustrate and bind an edition of 3,000 copies each, of these two reports. As already indicated, other economic reports will be ready for the press, during the coming year, and the year following; and provision should be made, for their publication. In making this provision, it should not be lost sight of, that there has been a great increase in the cost of paper, printing and binding, in the last two years; and that the present contract for the State's printing is at much higher rates, than the one, in existence three years ago. For this reason, it will require considerably more money, to print and bind a given volume, in the same style as heretofore. As advertising matter of the State's material resources, it undoubtedly pays, to issue the publications of the Geological Survey, in first class style. This, I have attempted to do, as far as the appropriation would permit, believing it to be for the State's best interests; and I have reason to believe, that much good has come to the State, thereby.

SOME RESULTS

A reasonable amount of pride in the greatly improved condition of the mining industries of the State, following the economic work of this Survey, on several important subjects, leads me to mention some results, that appear to have been largely influenced by the reports of the Survey.

Prior to 1894, there was no large building in this country, constructed of Georgia marble; but, since then, the following large buildings have been erected of this stone:— St. Luke's Hospital, New York City (in part—100,000 cubic feet); the Corcoran Art Gallery, Washington City; the State Mutual Life Assurance Company's building, Worcester, Mass. (Cost, \$900,000); the Rhode Island State Capitol, Providence, R. I.; the Minnesota State Capitol, St. Paul, Minn. (250,000 cubic feet); and the Century office-building, St. Louis, Mo. Two handsome, though smaller, edifices, of Georgia marble, are the State Savings Bank of Detroit, Mich., and the Carnegie Public Library, of Atlanta, the latter now in course of erection. For pillars on either side of the entrance to the bank, the Southern Marble Co., of Marble Hill, Ga., quarried, in April, 1899, and shipped to Providence, R. I., to be dressed, two mammoth monoliths of white marble, each measuring 27 ft. 2 in. by 4 ft. 4 in. by 4 ft. 3 in., and weighing 100,066 lbs. On being finished, they were shipped to Detroit, where they stand as magnificent columns at the entrance to the bank. Two duplicates of these were also quarried, to be used in case of emergency.

It is worthy of note, that, of these large buildings, two of them are located not a great way from the extensive marble quarries of

Vermont—at present, the leading State in the Union, in marble production.

The remarkable impetus, which has been given the gold mining industry, since the publication of our report on the larger part of the Gold Deposits of Georgia, is seen most conspicuously in the organization of the Dahlonega Consolidated Gold Mining Co., with a capital stock of \$5,000,000, and the purchase by that company, of a dozen or more of the best known gold properties in Lumpkin county, and the erection of one of the largest gold mining plants in the United States, on one of its properties. The principal features of this plant are a 120-stamp mill, with all the modern improvements, and a chlorination plant, with a capacity of 40 tons of concentrates per day. This company is doing extensive development, on some of its properties; and, it is said, with gratifying results. Between \$400,000 and \$500,000 have been expended by it, during the past year, in improvements and development work. The Standard Gold Mining Co., of Dahlonega, was organized last March, with a capitalization of \$5,000,000. This company, also, has invested in some of the best gold properties in Lumpkin county; and I am informed, that they are undertaking extensive work of development, with the view to erecting a duplicate of the plant of the Dahlonega Consolidated Gold Mining Company. The Crown Mountain Gold Mining Company, with a capitalization of \$2,500,000, and the Briar Patch Gold Mining Company, with a capital stock of \$2,000,000, have also been organized, with headquarters at Dahlonega. Each of these companies has purchased valuable gold properties in the vicinity of Dahlonega, and I am informed, that they have provided for the building of large mining and milling plants.

As a special help to the owner of a large tract of iron lands in

Bartow county, I furnished him a copy of the iron ore report on his property, in advance of publication, with the result, that the property was recently sold, for a good price, to a New York syndicate, which, it is said, will soon put up a large plant for the manufacture of iron.

One of the effects of our report, on a part of the Clay Deposits of Georgia, has been the capitalization of one of the properties surveyed, at \$250,000, by a New York syndicate, which has already begun to put up a plant for the manufacture of this clay into china etc.

In addition to these instances, there has been a general increase in mining activity over the State.

ACKNOWLEDGMENT TO THE ADVISORY BOARD

In conclusion, I wish to acknowledge my indebtedness to the Advisory Board, for the continued expression of interest, on the part of each member, in the success of the work of the Survey, and for their intelligent help, in affording me every facility at their command, for doing the work to the best possible advantage.

Very respectfully yours,

W. S. YEATES,

State Geologist.



